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THE BRITISH SECOND CLASS CRUISER DORIS.

THE accompanying engraving shows the second class cruiser Doris as she lay upon the ways just before her launch from the ship building yard of the Naval Construction and Armaments Company, at Barrow-in-Furness, England.

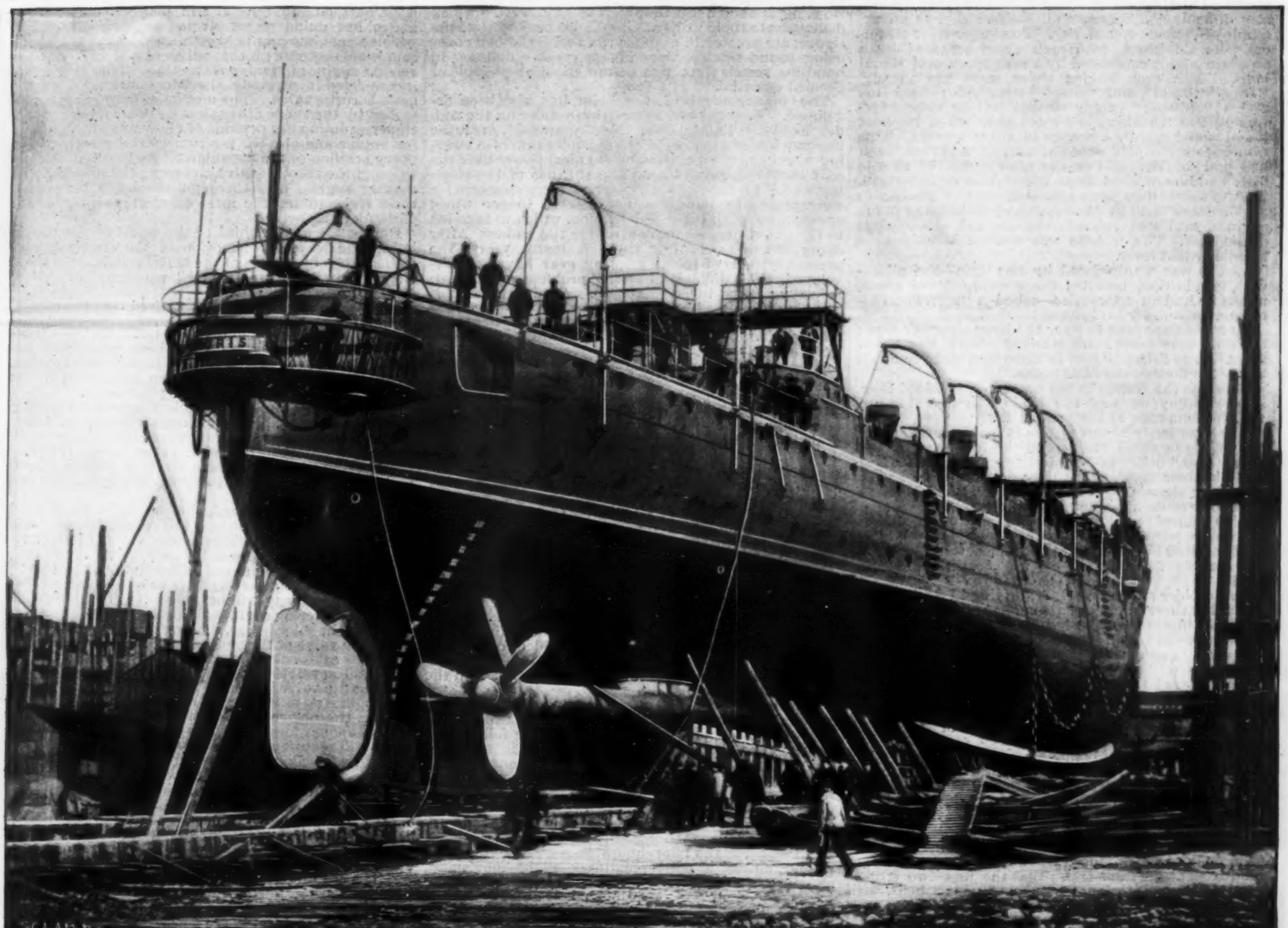
She is one of what is known as the Minerva class, of which there are in all six building by contract, and three completing in the government dockyards. The designs of the Doris are based upon those of the Apollo class, of 1889, of which there were some thirty ordered under the Naval Defense Act. The former vessels were of 3,400 tons displacement, 20 knots speed, and carried two 6 inch and six 4·7 inch rapid fire guns. Before the whole thirty were built, the designs were improved and enlarged, and the remaining eight were built of the following dimensions: Displacement, 4,360 tons, speed 20 knots, armament two 6 inch and eight 4·7 inch rapid fire guns. In the Doris the displacement, armament, and coal storage are still further increased as shown by the following table: Length 350 ft., beam 53 ft., draught 20 ft. 6 in., armament, five 6 in. rapid fire guns, six 4·7 in. do., eight 12 pounder do., seven 3 pounder do., four machine guns, with five torpedo tubes, displacement 5,600 tons, and speed 19·5 knots.

In describing these ships, Engineering, to whose courtesy we are indebted for our engraving, says: "The addition to length has enabled the same speed to be got practically for the same power as in the Latona, notwithstanding the increased displacement, which represents a very material addition in offensive and defensive qualities, there being five instead of two 6 in. quick-firing guns, a heavier protective deck, with quite double the radius of action, owing to larger coal, ammunition, and provision storage capacity. For instance, the thwartship coal bunkers in the new ships occupy 24 ft. of the length of the ship apart from the broadside coal spaces, against 16 ft. in the Latona. Again, the length taken up by magazines is 58 ft. forward and 42 ft. aft, in all 100 ft., against 42 ft. and 32 ft. respectively in the Latona. There is greater height too. There is also more length of the ship given over to provision stores, so that the vessels from every point of view can keep the sea for a longer time, and maintain a fight for a greater period—two most important qualities for vessels fighting at a distance from a base of action."

The extra 2,200 tons of displacement is devoted to the hull, in which the plating and scantling are heavier, and to increased coal and stores supply, the former being 1,100 tons, as against 552 tons in the Latona. The deck plating has been increased from one inch on the flat and 2 inches on the slopes to $1\frac{1}{2}$ and 3 inches respectively.

The new ships will have five 6 inch rapid fire guns in place of two. "On the forecastle there is one of those guns firing right forward and 30 deg. abaft the beam, and on either side on the upper deck there is a 6 inch gun training from right forward to 60 deg. abaft the beam; the two other of the five guns are placed on either side aft, the four on the upper deck being built out on sponsons so as to fire in line with the keel. The broadside guns on the same deck are six 4·7 inch quick firers. On the main deck below there are nine 12 pounders, four of which are on each side and two on the forecastle firing right forward, and two under the poop. In the new boats there are military tops; the top on the forward mast is 10 feet higher than on the mizzen. These fighting tops have each two 3 pounder guns installed in them. The cruisers of the Latona class had no military tops. The new boats have two submerged and one above-water stern tubes for the firing of torpedoes; the Latona's four tubes were all above water. This change has been accompanied by a liberal space for submerged tube rooms, while there is a well equipped torpedo workshop, the ample room provided suggesting the importance attached to the work."

The cruiser in our own navy which most readily compares with these ships is the Olympia, which was fully described and illustrated in the issue of the SCIENTIFIC AMERICAN of March 21, 1896. The Olympia is 200 tons larger than the Doris, and on every point of comparison, except coal storage, she is better equipped. She has 17,363 horse power, against 9,600; 21·68 knots speed, against 19·5; and a 2 inch to $4\frac{3}{4}$ inch deck, against $1\frac{1}{2}$ to 3 inches in the Doris. Her main armament consists of four 8 inch rifles and fourteen 5 inch rapid fire guns, against five 6 inch and six 4·7 inch rapid fire guns. It is probable, however, that in stowage for coal and stores and in accommodation for the crew the Doris is better provided; the long cruises incidental to English naval service demanding that such provision shall be ample.



THE BRITISH SECOND CLASS CRUISER DORIS, JUST BEFORE THE LAUNCH.

The great bulk of the granite output comes from the vicinity of the eastern coast of the United States. The States Massachusetts, Maine, Connecticut, Rhode Island, Georgia, New Hampshire, Pennsylvania, Vermont, Maryland, New Jersey, Virginia, New York, Delaware, North and South Carolina produced in 1889, 77·72 per cent. of all the granite produced in the entire country, and the New England States produced 55·52 per cent. of the entire output, valued at $8,031,161. Massachusetts and Maine were first and second, respectively, Connecticut and Rhode Island fourth and fifth, New Hampshire seventh and Vermont ninth in the value of product.

SPEED CONTROL IN MODERN STEAMERS.*

By LIEUTENANT M. L. WOOD, U.S.N.

WHEN steam was applied to the propulsion of vessels, the control of the speed was effected by means of verbal orders passed along the deck to the engine room. The boys employed on board the early passenger steamers in the Thames seem to be conspicuous in the accounts of travelers in those days.

In ocean steamers a system of communication was gradually developed which was in general use up to within a few years. This consisted of signals transmitted by ordinary bells, of which two were used, one a single stroke gong and the other a "jingle bell." The signals in common use were as follows with the single stroke bell: One bell (when stopped), "ahead slow." One bell (when going ahead full speed), "slow." One bell (when going ahead slow or backing), "stop." Two bells, "back." The jingle bell indicated full speed on engine, whether backing or going ahead. It was also used to indicate "stand by the engine" or "through with the engine." This system has stood the test of extensive practical use in all sorts of vessels, giving satisfaction until the introduction of more modern means. It will be noticed that the meaning of the signal depends upon preceding signals and the action of the engine at the time. A slight lapse of memory or of attention at critical moments might result in misunderstanding the signals for working the engine, with possible damage to the vessel itself or to others in close quarters.

The extent to which a system of sound bells can be developed is shown in some of the Western river steamers of the United States. The old Mississippi River steamers, where the strong current, sharp bends, frequent eddies, with the necessity for stopping, in case of a hail, at almost every plantation landing with the bow up stream, have a very efficient system which serves admirably for handling vessels under exceptionally difficult conditions, and, incidentally, as an example of extreme complexity. The larger river steamers were sidewheel, with each wheel actuated by a separate engine controlled by a complete set of signal bells. For each engine there were "go ahead," "stop," "back," and "slow" jingle bells; there was also a "shifting" (single stroke) bell to indicate reversing the "hooking-in" valve gear when the next signal would require a change in valve motion. This would seem complex enough, but, in addition, each bell had double pulls in the pilot house, so all the bells could be worked from either side of the wheel. Besides these there were also bells to the firemen to "open doors" and to "fire up," and to the gang plank engines, with voice tubes to engines and other parts of the boat. The whistle was worked usually by a treadle or foot lever.

All this was manipulated by one man—the pilot—who, in addition, handled the steering wheel alone, unless he had an apprentice—called a "steersman"—temporarily under his instruction.

To enable one man to steer the large steamers along their devious track, the steering wheel was made large, ten to thirteen feet in diameter, with the axle below the floor of the pilot house.

This was the system in use on the Mississippi River in the palmy days of the trade, and is still in use, with few changes, at the present day.

One peculiarity of this system is that every signal to the engine signified "full speed" unless accompanied by a "slow" bell. The signals are nearly all "positive" in their meaning, as they do not depend upon preceding signals.

In spite of its apparent complexity, this system of engine control certainly served its purpose, as the engines were worked with a promptness and certainty that resulted in the delicate and efficient handling of the vessels necessitated by the conditions of the trade.

In the older steam vessels of the United States navy, including those yet in use at the present day, a system is in use differing from both those described, as it makes use of but one single stroke gong. With this system, one bell, "ahead slow;" two bells, "stop;" three bells, "back;" four bells, "ahead full speed." The advantages of this system are: that it requires but one bell, saving the cost of the second bell and the wiring, and also that the signals are positive, having but one meaning, irrespective of preceding signals.

The principal disadvantages are: that it is noisy, hard upon the bell connections, that it is liable to fail at critical moments if signals are given under excitement or by an unpracticed hand; that it is slow, as time must be lost waiting to see if there be a following stroke, which may change the signal completely; if obeyed too quickly and therefore improperly, hesitation no doubt is produced by the attempt to go ahead and back at the same time; that the first two strokes of "four bells" is often mistaken for two bells, with the result that the engine is partially slowed, or even stopped, when "ahead full speed" is required to avoid accident; last, but not least, there is no provision for backing full speed, which may be the only means of averting danger.

In fact, the "four bell" system is about the worst in use anywhere. Its disadvantages come out strongly in the case of smaller vessels making frequent landings, and in these it is usually avoided by the adoption of the merchant code whenever practicable without attracting official attention.

There is a system of signals to the engine room suitable for use on board vessels where it has not been deemed expedient to fit modern engine room telegraphs, which has been developed probably by accident, but which has stood the test of practical working wherever tried. In this, two bells are used, a single-stroke bell and a jingle bell. The signals are as follows: One bell, "ahead slow;" two bells, "stop;" three bells, "back;" jingle bell, "open throttle," i. e., "full speed" on the engine, whether going ahead or backing.

The advantages of this are numerous enough to warrant its adoption on board all vessels of the navy not fitted with engine telegraphs. The signals are all "positive," since they do not depend upon preceding signals. The reliability of the bell is improved, as it does away with "four bells," with its chance of breaking down or of confusing signals. It also furnishes the important signal "astern, full speed," which is an important one. The only change required to introduce this system would be the placing of a second bell on board vessels. This expense will be very slight compared with the lessened risk of damage due to more efficient handling.

In all these systems using sound codes, the only information given to the pilot house as an indication of the proper transmission of the signal is the sound, assisted by tubes, of the bell itself, which, for this purpose, is much louder than would otherwise be necessary.

In modern steamers the necessity for quicker and more reliable signals to the engine room has developed the use of engine telegraphs, using visual signals in place of sound signals. As at present in use on board all, or nearly all, modern steam vessels, the engine room telegraph, whatever may be the special design, consists essentially of a small lever moving over a dial on the bridge connected by various mechanical means with a pointer in the engine room, whose motions are made to correspond exactly over a similar dial. Each position of the lever with the corresponding motion of the pointer indicates a signal and rings a bell to call attention. The signals transmitted are as follows: "Ahead, full speed," "three-quarters speed," "half speed," "slow," "stop," "back slow," "three-quarters speed," "full speed astern." Sometimes other intermediate signals are used. The indication that the signal has been received is a return signal made by a lever in the engine room which moves a pointer over the telegraph dial on the bridge repeating the signal and acknowledging the receipt of the signal to be carried into effect. The motions of the propeller shafts are shown by indicators in the pilot house which indicate the motion and the direction of motion of the engines.

There are several designs which work efficiently upon the principles stated generally above. Their working is shown by thorough tests in service which demonstrate their utility. It will be noticed that the signals are greater in number than with the bell codes using sound signals, thus giving greater delicacy in handling vessels than was before thought possible or deemed essential.

The management of the helm has also been developed. Vessels were steered by a tiller on the rudder head by hand power directly applied, until the increase in size of ships led to the adoption of a steering wheel to give increased mechanical power over the movements of the rudder. The shifting of the steering wheel to the forward part of large steamers for convenience in handling necessitated longer wheel connections, with increased friction, which in turn led to the use of engines for controlling the rudder. After many attempts, lasting through many years, the present systems of steam steering gear have been developed. The difficulties of the problem were great. A heavy rudder, in large vessels, weighing thousands of pounds, exposed to violent shocks from waves, was to be moved either by slight changes, starting from any position, or rapidly, from one side to the other. This motion had to be under perfect control, since the rudder was, by the conditions accompanying its use, required to follow exactly the motions of the steering wheel on deck. Too much motion of the rudder was as bad as too little, since its duty is to steer a large, fast steamer to degrees of arc on her course, or, on the other hand, to change direction suddenly to avoid danger. These mechanical difficulties have been completely overcome, there being several designs of steam steering gear which can now be relied upon in every respect.

The general design of all the patterns is about the same, the principal differences being in the means used to attain the end. Steam steering gear in general is as follows: A small steering wheel in the pilot house, or on the bridge, in the forward part of the vessel, is connected by shafting and gearing, wire ropes, or combinations of both, to mechanism moving the valve of the steam steering engine in a compartment near the stern; this valve admits steam to the cylinders, revolving the drum in the direction decided by the motion of the valve. A small motion of the valve produces a small motion of the drum connected with the tiller by chains or gearing.

This limitation of the effect is produced by a "stop motion," differing in different systems, in which a lug or projection attached to a cut-off valve follows the valve by the revolution of the drum until it catches up with the valve, when it stops the engine, and, therefore, the tiller, by shutting off steam. It will be readily seen that the devices to produce this effect are necessarily too complicated for description here. They, however, have been found to do their work properly, and are thoroughly reliable. When the small wheel in the pilot house is moved slightly, the rudder makes a correspondingly slight movement, stopping in the new position, held firmly by the steering engine until the next movement of the steering wheel. The serious damage that would result to the pockets of the owners, and to the vessel itself, from erratic working of the steering engine in a crowded harbor can be easily imagined. This has resulted in the steam steering engine having been brought to such a stage of perfection in several patterns that it can be safely locked up in its compartment, after proper adjustment, with confidence that it can be relied upon to do its work for hours at a time. All steam steering gears are provided with arrangements for being thrown out of action in case of failure to act properly, but the cases of failure to work, when well installed and attended, are very few and far between.

As the movements of the rudder of a large vessel in a heavy sea are extremely violent, all parts of the steering engine are made with large factors of safety to withstand the sudden jerks

From the above it would seem a settled fact that the commercial steam steering engine can be relied upon to move the tiller in any weather in exact accordance with the movements of the steering wheel at the other end of the vessel.

To return to the discussion of control of speed. The question naturally comes up, Why is it not practicable to connect the engine telegraph, or a modified form of it, suitable to the new conditions, directly to the mechanism controlling the direction of motion with the speed of the engine, so as to work the engines directly from the pilot house instead of from the engine room platform?

It is the object of this paper to show that such a connection is practicable, that it can be made reliable, and that it is advisable, on the score of efficiency, by eliminating chances of error in transmitted signals, with increased rapidity in working engines, while preventing damage to engines and lessening the chance of accidents, by allowing constant general inspection while under way by those now stationed to work engines by hand in obedience to signals.

The following is the plan proposed for adoption without interfering with working the engines exactly as at present, when so desired. When the principle is once adopted, simplifications can be easily arranged, lessening the number of parts to suit the size of vessel and the different types of engines:

1st. Connect the engine room telegraph, modified to suit the work, or a special connection designed for the purpose, to a small pinion or suitable gearing, which will move the valve of a small commercial steam steering engine the full extent of its throw, by the movement of the lever in the pilot house, the motion being so adjusted that the "stop" position of the lever agrees with the position of the valve for "helm amidships." For convenience, call this small steam steering engine the "regulator engine." The pattern is immaterial, only the valve must be specially designed to move with as slight friction as possible, owing to the small travel of the lever.

2d. In place of the drum on the regular engine, fit a shaft, which, by worm and gear or rack and pinion movement, will move a frame sliding in horizontal guides, exactly as the tiller end is moved by a steam steering engine—the middle part of the travel of the frame corresponding with the "stop" position of the lever in the pilot house and with the "amidships" position of the valve of the steam steering engine used for the regulator engine.

3d. To the frame, called for convenience the "regulator," attach two vertical stiff plates. One of these plates has guide pieces riveted on, or a slot cut, in which a cam, moving in vertical guides, slides. This cam is connected with the valve of the ordinary reversing engine governing its motion. The other plate is connected in precisely the same manner with the main throttle valve. The motion of both cams is controlled by the shape of the slots in which they work, thus regulating the position of the valve of the reversing engine and also the position of the throttle. For every position of the "regulator" there is but one position of the throttle valve and one position of the reversing engine, also these positions will be exactly those required for the most efficient working of the particular engine.

During the middle third of the travel of the "regulator," the direction of motion of the engine is controlled, the outer parts of the travel regulate the speed from "slow" to "full speed" with any degree of nicety required.

In this connection it will be noticed that the motion given to the sliding frame, or "regulator," and the power available for moving the main throttle valve with the reversing engine are both practically unlimited, as both depend only on the power of the steam steering engine, having no relation in amount to the force exerted on the lever in the pilot house.

4th. Arrange simple accessible means for throwing the automatic engine control apparatus out of action on the shortest notice, allowing the engine to be worked by hand as at present, using exactly the same principle by which the steam steering gear is disconnected, leaving the tiller to be worked by hand in case of necessity.

The consumption of coal, the amount of steam used, with the speed constituting "full speed" for the time being, will remain entirely under the control of the chief engineer, as at present.

There is one mechanical difficulty that interferes with this plan at present. It is believed that, as soon as called for, a way will be found for its elimination. All steam steering engines are designed for use with a wheel in the pilot house, making one or more turns to move the valve of the steering engine its whole travel. This has allowed a worm and gear motion to be applied to the valve stem, so that the power available for moving the valve is great, and, therefore, in all steering engines no particular attention has been paid to reducing the power required to move the valve. The plan proposed for using these engines as regulator engines will require an easier movement of the valve than is usual with commercial steam steering engine valves. Manufacturers will be able to produce easy moving valves when once in demand, the more readily that as the regulator engine in this plan has to move only two light valves instead of a heavy rudder subjected to violent jerks, a very small, lightly made steam steering engine will handle the engines of the largest battleship.

The location of the regulator engine would be such as to allow the shortest and simplest connections with the engine room telegraph. It could be under the engine room floor or where least in the way. The location of the sliding frame would be close to the engines, where least in the way, against a bracket shelf on a bulkhead, under the engine room floor, or overhead—the location, except for convenience, being immaterial, as it is to be moved by gearing and shafting from the drum of the "regulator," which can be given all the power needed. The motions from the cams to the reversing engine and the throttle are communicated by bell cranks or other suitable connections.

To the regulator may be attached projections which will ring as many bells as required at every change of speed, with arrangements for disconnecting all bells when quiet is desired, as in seeking or avoiding an enemy in a fog or in the dark. Bells governing the firing under the boilers can also be worked for routine changes.

The auxiliary machinery, such as circulating and air pumps, can be controlled with but little trouble by additional slots and cams. In fact, all routine movements now performed by hand successively can be arranged to take place at the exact time required for efficient working without the possibility of mistakes.

Speed recorders can also be attached to the "regulator," which will give "hodographs" or speed curves,

* From the Proceedings of the United States Naval Institute.

as decided by the position of the throttle, on a slip of paper worked by clockwork and tracers, using the principles of the "barograph" and ordinary engine "indicator." This will avoid the necessity for constant notes of changes of speed, while it will give an accurate record for a watch or for a week, from which the important data may be taken for entry in the log book.

The speed of the regulator with the movements of the throttle can be so adjusted by experts that the possible danger to the main engine which might result from carelessness or incompetence in working by hand can be entirely avoided. Even the water valves may be opened automatically in starting the engine from rest.

No provision is made for the sending of any return signal to the bridge while working automatically, as the motion of the engine will show on the "engine indicators" in the pilot house, and will be the best and surest indication that can be devised. When the automatic control is disconnected, the motion of the answering pointer on the engine telegraph will then be in operation and will serve as a signal that such change has been made.

In case it be assumed that the engine telegraph cannot be made strong enough, or the friction of the valve with its resistance reduced sufficiently, the valve on the regulator engine can be made to move by a lever of sufficient power, connected with the valve by means similar to but lighter and simpler than the connections to the steering engine in the steering engine compartment.

If the plan has been carried out properly in the original design, as long as all parts were in adjustment with everything working properly, no more care or attention would be required by the regulating engine than by the steering engine. It would be possible to lock it up, with only occasional visits for inspection. The work of the regulating engine would be less frequent than that of the steering engine when under way, besides being also much lighter in character. There seems no reason why it should receive any more attention or require even as much care. In case of anything not working properly or any adjustment being required to either regulator or main engine, or in case of accident, the regulator can be disconnected, throwing in operation the usual engine room connections to engine telegraph. As soon as put in order, the regulator can be thrown in action. An emergency throttle can be used to shut off steam suddenly from the engine room. While getting up steam the regulator engine and its connections can be tested and reported ready for use in precisely the same way that the steam steering gear is tested and reported at present.

The primary object of the automatic working of the main engines directly from the deck is increased efficiency. Time will be saved by its use, as well as the elimination of the chance of accident from misunderstanding or faulty execution of signals. Such mistakes have happened with the best men at the throttle and may happen again. The power of working the *engines at all times* may be of vital importance. A small piece of a projectile during battle might cut even a small auxiliary pipe filled with live steam, which might make an engine room uninhabitable before steam could be shut off. The destruction of the draught might fill the compartment with poisonous gases. During the time the engine room was thus cleared of living beings might occur a critical moment, when the safety or destruction of the vessel would depend on the handling of the engines promptly. The plan proposed would allow the engines to be controlled the same under such conditions as at any other time.

In a vessel dependent on the motion of the engines for propulsion, the importance of the proper working of the machinery at all times, but especially in action or in times of danger, cannot be overestimated. A collision or a torpedo explosion might result in such danger to those below decks that the engine room would be cleared on account of the possibility of going down with the ship. Control of the engines from the deck would prevent the loss of life due to the vessel sinking while going through the water, or carrying down those remaining at the post of duty in the engine room.

This suggestion of automatic working of the engines of a vessel of war from the deck is not intended to lessen the responsibility of those in charge of the machinery, although it incidentally makes the work easier by giving relief from the suspense of waiting for signals which do not come, and by allowing freedom of movement to inspect the proper working of all parts of the engines. In fact, it will really add an additional machine or two to be kept in order and in adjustment, to the already large amount now on board modern vessels of war.

It is intended to increase the efficiency of the vessel by quicker handling of the engines directly by the movements of one lever, by the elimination of chances of human error in carrying signals into execution, and by allowing those on watch in the engine room, when under way, freedom to inspect bearings or detect imperfections in the working of the machinery in time to take steps to prevent accidents or delays. In the case of a twin-screw vessel it really adds at least two—presumably the best in the watch—to those available for general inspection of all parts. It is not considered necessary to have an expert standing by the steam steering engine when working the rudder, and it will not be considered necessary to have an expert standing by the same engine doing very much simpler duty in the engine room.

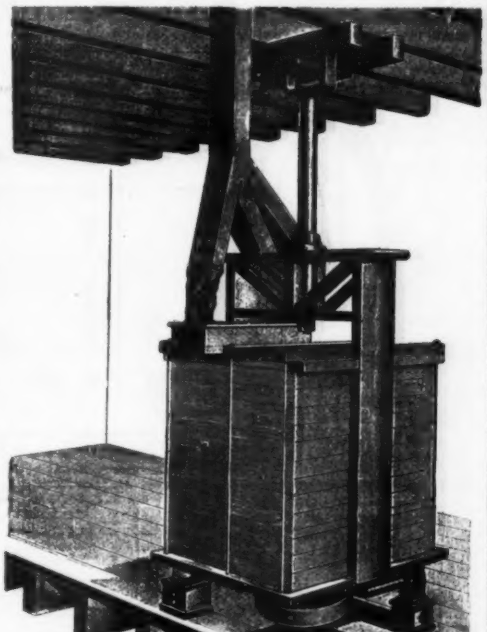
That it requires a higher order of intelligence to keep machinery in order or to design new appliances than it does to reverse an engine or handle a throttle lever in answer to signals, is so self-evident that no apology is deemed necessary for suggesting automatic speed control from the deck to those in charge of the designs of vessels of war.

Various changes will suggest themselves to experts looking over the details of the plan here proposed for speed control. The details as given may appear cumbrous, as the one idea has been to make the principles clear, and this could be done only by sacrificing small details to bring out the general effect. Keeping the reversing engine available for use when desired has also added unnecessary parts. The reason for these defects in the plan is obvious. When once the principle is adopted, there will be time and opportunity for introducing improvements in many directions to save room and get rid of useless parts. The regulator can move vertically if horizontal space is scarce, or the worm gear can be on top if desired. As suggested in this paper, with only minor changes to give more compactness, it can be adopted and installed in existing engine rooms with but little loss of space. When part of the original design, it can be still further improved by combining regulating with reversing engines, with many other simplifications.

The sketches accompanying this paper are, therefore, to be considered as designed to exhibit principle and not for actual construction. The proportions are chosen to show parts, and not the exact sizes of those parts or their relations to others.

The practicability of working the regulator or even the engines by other than hand power or steam is not considered sufficiently tested to warrant its recommendation. When vessels are steered by electricity as much as they are with steam, it will be time to use that method of handling engines, and by the same mechanism used to control the rudder.

The location of control points on board a man-of-war is an important question. In general, for fighting purposes, conning towers will be placed as far forward as possible, where the view ahead is least obstructed. On the other hand, the efficient working of the guns requires that the gun fire shall be unobstructed. The chance of being hit by enemy's projectiles calls for a low position, with a shape to resist serious damage as much as possible. The compromise will probably be that the conning tower will be



CARTER'S PENDULUM SIFTER.

hemispherical, with a tunnel entrance from the upper deck, and that its location will be abaft the forward guns and forward of the mast and smoke pipe. It will probably have just enough elevation to allow the view to be unobstructed. A second conning tower will probably be placed in a similar position aft. It may also be deemed advisable to have a conning place in an armored top on account of the many advantages of the elevated position. When not in action, a well equipped bridge, pilot house and chart room will be located about in the position given above to the forward conning tower. These questions, involving the exact control points, will be determined by the type of vessel and need be no further considered in this paper, since wherever the engine telegraphs are located in the design of the vessel the same leads and connections would be suitable for the automatic control of the engines from the same points, with the same appliances for throwing out of gear the apparatus not in use at the time. Any point suitable for an engine telegraph will be equally suitable for the use of automatic control from that point.

This plan of automatic control of engines from a distance, besides being adapted for exact and delicate handling of vessels, is also applicable to handling turrets. The lever being in the turret, where most convenient, with the engine working the turret below out of danger and where it will give the best results. The connections being the same as at present, by means of a sliding collar on the spindle with a diminutive regulator below the turret, as described for working the main engines. The regulator could be overhead, and its travel, with accompanying delicacy of handling, arranged to any degree of fineness desired. As all the working parts would be small, many parts could be combined, with resulting compactness. The turret could be made to move as slowly as desired without jerking, owing to the regulation of the amount of steam, or as rapidly as the engine could work safely.

The following is a résumé of this plan for the automatic control of the main engines of a vessel of war:

1. The use of as direct and as frictionless connections as practicable for transforming the motion of a lever in the pilot house into motion of the valve of a small, light-working steam steering engine used as a regulator engine in the engine room of the vessel, so that the valve follows exactly the motion of the lever.

2. The following of the motion of this valve of the regulator by a drum, exactly as is done by the steam steering engine.

3. The transformation of the motion of the drum of the regulator engine into the rectilinear motion of a sliding frame or regulator, so that the latter follows exactly the motion of the valve, and, therefore, the motion of the lever, but over a longer space and with more power, in the same manner that the tiller and rudder follow the motions of the steering wheel.

4. The transformation of the motion of the regulator to motions of two rods, one of which controls the motion of the valve of the reversing engine, or the links of the main engine, and the other controls the position of the throttle valve of the main engines. This also produces the motions requisite for ringing bells anywhere, and for starting in operation and slowing auxiliary machinery necessary to and dependent upon the working of the main engines, to any extent deemed advisable.

5. Readily accessible means for throwing the automatic control out of gear, leaving the engines to be worked exactly as at present.

As to its originality, it can be said that the plan proposed is original with the writer in so far as it is applied to handling of engines on board large vessels by means of the steam steering engine principle. That is believed to be entirely new and is believed to be the keynote of success. As to the idea of working the engine direct without a second man to receive a signal, that is done in thousands of locomotives in everyday use. As a matter of fact, it will require less manual power in the pilot house of a large steamer to work the engine by means of the regulator described in this paper than it does to work the massive lever in the cab of a railway locomotive, in spite of the longer connections and the greater size of the vessel's engines.

The locomotive idea has been applied to direct working of the engines of small vessels with double engines, and there are several patented devices in successful operation.

I know of no patents, existing or future, covering the ideas advanced, and think the plan capable of development.

The following are some of the advantages which would attend the adoption of automatic control of engines:

1. Avoidance of errors and accidents due to misunderstanding or poor execution of signals from deck.

2. Quicker working of the main engines, since the motion of one lever on the bridge acts directly on both the reversing engine and the throttle. The engine will be worked in the same time it now takes to make the signal.

3. Complete control of the engines while steam is in the boilers, in case an accident to a steam pipe or the draught makes the engine room untenable, or a serious incident, such as being rammed or torpedoed, forces those in the engine room to leave their post.

4. Greater efficiency in handling the engine with increased security from accidents due to imperfections in machinery or its working, by allowing those now stationed strictly on the engine platform when under way to move freely about the engine room, inspecting all parts more frequently.

5. Relief from constant strain of those now stationed to watch engine room telegraph when under way.

6. Adaptability to any form of engine without lessening usefulness of present system of reversing engines by hand.

7. Ready return to existing style of working engine when so desired.

8. Adaptability of present connections of engine telegraph to new system of working engines without any increase in number of parts or the use of untried systems of connection.

9. Exact and delicate adjustments of speed to suit the exigencies of squadron evolutions in close order.

I offer this plan with a great deal of diffidence for discussion by the institute, and in the hope that something may be done to develop an idea in what I believe to be the right direction. No one has ever complained of the introduction of small engines in place of manual power for reversing ship's engines. This plan, with all of its imperfections, is a further step in the same direction. It is bound to come, and the sooner the better.

CARTER'S PENDULUM SIFTER.

OUR illustration, for which we are indebted to the Engineer, of London, represents a device called a loose silk pendulum plane sifter, although the loose sifting material is not a plane—for scalping, grading, and dressing flour. This appliance was exhibited by Mr. J. Harrison Carter, of Dunstable, and is said to give better flour while occupying less floor space and consuming less power than the ordinary centrifugal dressing machine. The pendulum, which is really the body of the machine, is composed of a series of sieves placed one above the other, and the feed entering at the top passes over each of the sieves till the overtails leave at the bottom. The flour—separated from each sieving—falls on to a canvas fixed tightly over the silk of the next lower sieve, and is then by the pendulum or gyratory movement conveyed to openings through which it falls to the tray at the bottom. Thus the flour at the bottom is taken off at the same sleeve. The pendulum is suspended from one point only, a universal ball bearing in the center of the machine, by which the weight is taken. By the eccentric motion of the crank from underneath, its axle moves in the mantle of a cone, and the sieves incline alternately in every direction, thus imitating the hand sieve movement. By securing the silks loosely over the frames, folds or undulatory waves of the fabric are produced by the gyratory movement, and the material being sifted keeps these undulations in constant movement. It is claimed that this feature obviates the necessity of a cleaning device for the silks. The floor space re-

quired by this machine is 3 ft. 6 in. by 3 ft. 3 in., and the head room 8 ft. 6 in., while the speed found to give the best results is 175 revolutions per minute.

THE WORKS OF AN INVENTOR OF THE SEVENTEENTH CENTURY.

AMONG the names of the illustrious men of the period in which he lived may be mentioned that of Nicolas Grollier, who from the title of the baronetcy of his father, Antoine Grollier, is often called de Serviere or simply Serviere. He was born at Lyons in 1596, and at the age of fourteen decided, in imitation of his ancestors, upon a military career. After distinguishing himself both as a soldier and an engineer in many years of active service in Italy, Flanders, Holland and France, he retired from the army, in order to spend the remainder of his life in scientific work.

Being independent in his circumstances, and having a taste for mechanical and mathematical researches, he was led to the establishing of a cabinet of models of rare and curious apparatus, many of them of his own invention and exhibiting remarkable ingenuity.

An account of a part of these is included in a small volume edited by his grandson.* This work is divided into three parts. The first of these relates to objects formed upon the lathe, such as spheres, cubes, ellipses, etc., some of which are hollow and contain others within them, like Chinese balls, and all of them extraordinary specimens of workmanship. There are also vases, urns, etc., not only round and elliptical, but angular, so that not only were oval and eccentric chucks known to Serviere and used by him, but also apparently the lathe for turning irregular surfaces. The second part of the work is devoted to an account of clocks, all made by himself, and the mechanism of which is very ingenious. Some are actuated by springs, and others by weights, water, sand, etc.

They are fully equal to anything of the kind produced at the present day; indeed, that beautiful device by which a small brass ball is made to move backward and forward over an inclined plane, and which still retains a place in mantel clocks, is one of Serviere's inventions, as are also several modifications of it equally interesting. One-half of the third part of the book is occupied with descriptions of machines for raising water. These consist of gutters, swapes, chain pots, gaining and losing buckets, nories, tympanums and other wheels, etc. The remainder of the work is devoted to bridges, pontoons, military engines, ladders, measuring devices, articles of furniture, drawing apparatus, etc.

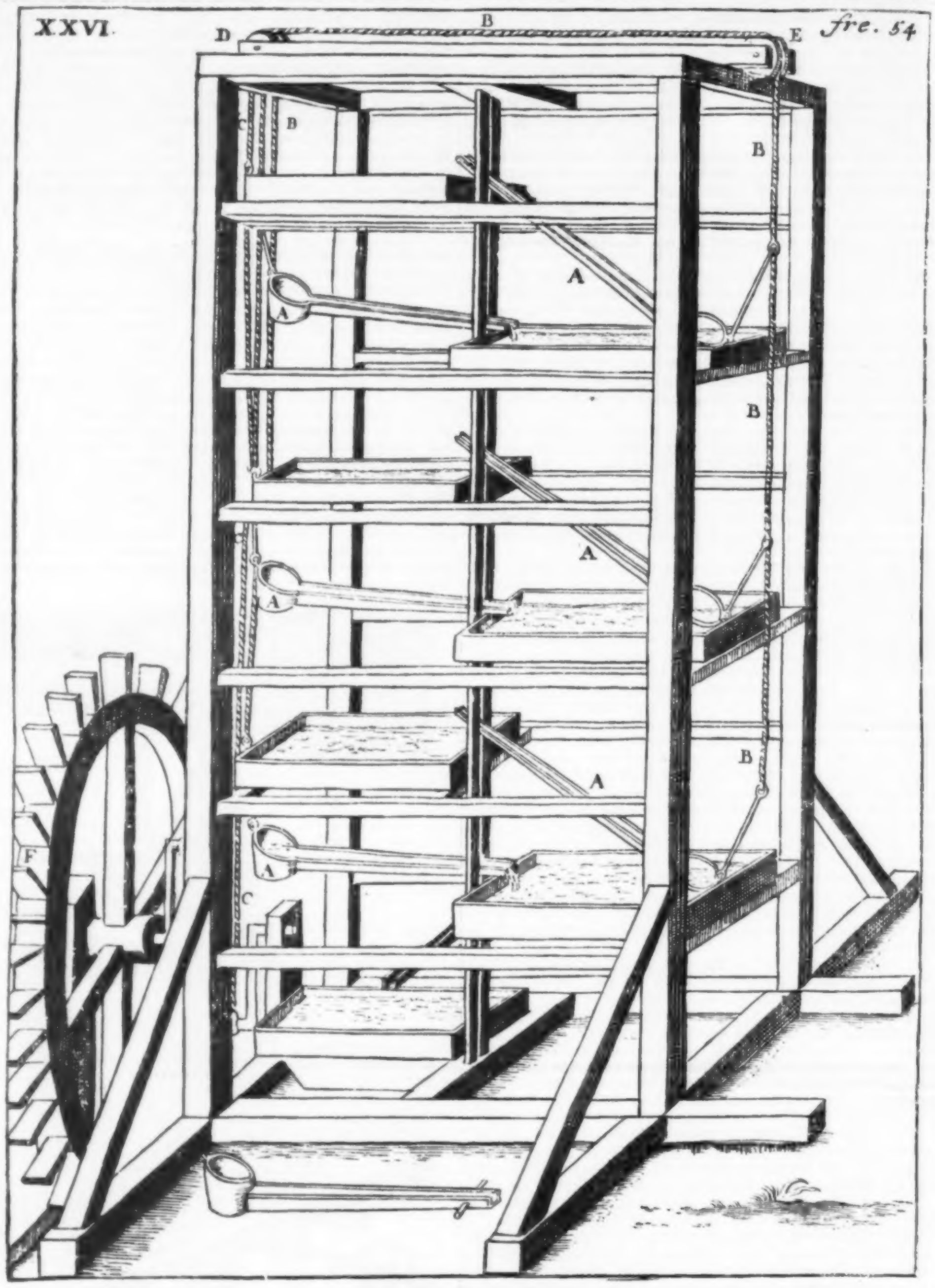
As examples of the contrivances of this old inventor, we shall reproduce a few plates, with descriptions, from the volume under consideration, selecting these at random and giving them, as well as the separate figures, the same numbers as are found in the book.

MACHINE . . FOR RAISING WATER FROM A RIVER UP TO THE TOP OF A LARGE TOWER.

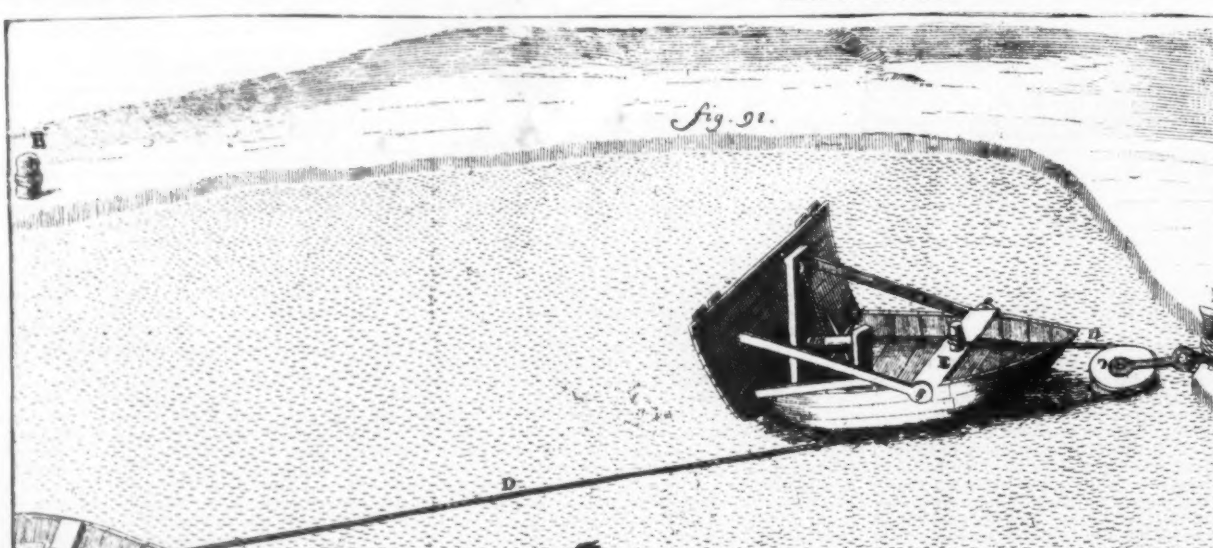
(Plate XXVI, Figure 54.)

In this machine, the bowls, A, are simply suspended by the ropes, B C, which pass over the pulleys, D E, and which are attached, through rings, to the two cranks of the axle of the large wheel, F, so that when this wheel, F, revolves, the two cranks of its axle alternately tauten and slacken the two ropes, B C, and thereby cause them to raise and lower the bowls, A, which draw up the water and empty it into the different reservoirs, from one to the other, up to the top of the tower.

* Recueil d'Ouvrages Curieux de Mathematique et de Mecanique, ou Description du Cabinet de M. Grollier de Serviere, avec des figures en taille douce, par M. Grollier de Serviere, son petit fils. A Lyon, 1719. [2d edit., 1733.]



MACHINE FOR RAISING WATER FROM A RIVER UP TO THE TOP OF A LARGE TOWER.



MACHINE FOR CAUSING LARGE LOADED BOATS TO ASCEND A RIVER WITHOUT BEING TOWED EITHER BY MEN OR ANIMALS.

MACHINE FOR CAUSING LARGE LOADED BOATS TO ASCEND A RIVER WITHOUT BEING TOWED EITHER BY MAN OR ANIMALS.

(Plate LXII, Figure 91.)

The number of men, horses or oxen required to tow loaded boats upon rivers entails an excessive expense that might, however, be saved by the use of the present machine. It is very simple, and may produce its effect equally upon all sorts of rivers, whether the currents be slow or swift. To cause the boats to ascend, we employ here only the force of the river currents, and what in ordinary practice is the great obstacle to be surmounted is here the prime mover of the execution that is proposed. Upon the banks of the river that you wish to have your boat, A, ascend, set and drive home strong piles here and there, like those marked B, each of which should be provided with a good iron ring for fastening the large pulley, C, thereto when necessary.

We usually attach a rope, D, to the loaded boat, and after passing it around the pulley, C, fasten its other end to the second and empty boat, E. As these two boats thus attached to each other have their fulcrum at the pulley, C, they would remain upon the river without advancing or receding were they of equal size, or, better, were both of the same draught; and certainly the one upon which the river currents produced the greatest thrust would cause the other to ascend. According to this undeniable principle, our entire attention for causing the boat, A, to ascend should be devoted to finding a means of making the boat, E, draw more water than the boat, A, naturally draws. In the idea of this machine, such means is very simple and very natural. It consists merely in the piece, F, that we shall call a wing, and which may when need be, be lowered into the water, or raised therefrom, as the figure shows.

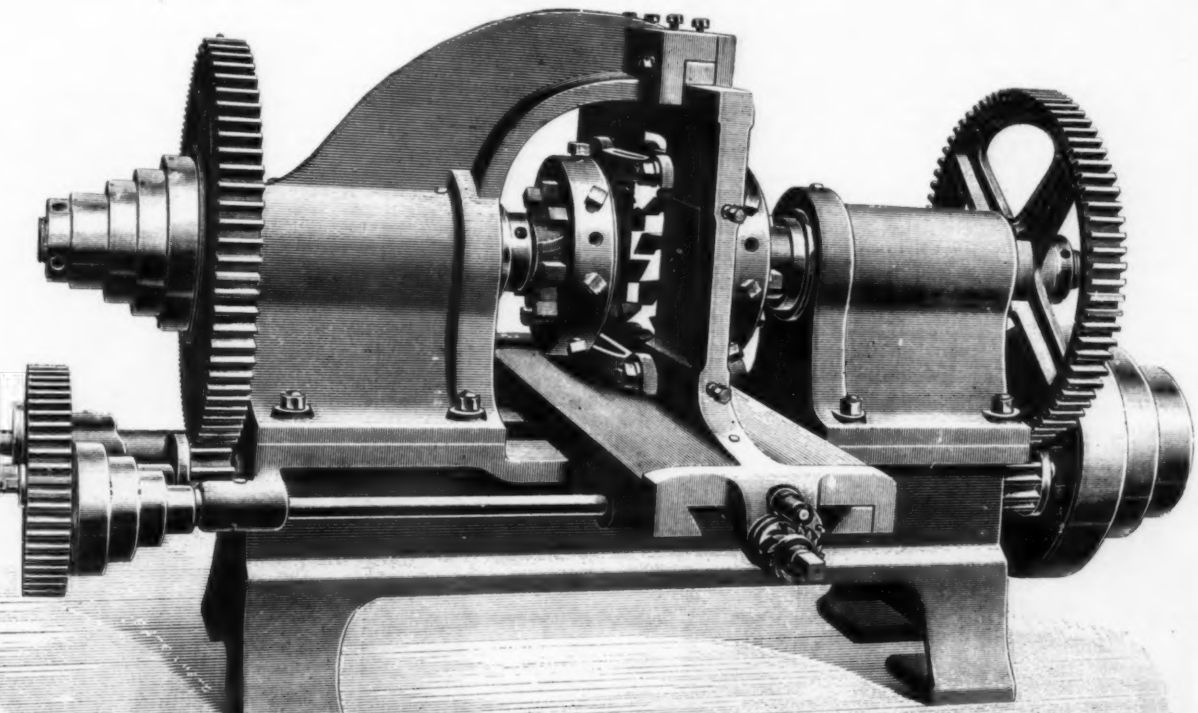
This wing, F, draws more or less water, according to its depth in the river; and all the force that the currents exert upon it is felt by the boat, E, to which it is attached. So, having constructed such a wing according to the proportions that it should have in order to cause the boat, E, to draw more water than it is possible for the loaded boat, A, to do, the former, although much smaller than the latter, will, when its wing is lowered into the river, be obliged to descend, and consequently, by means of the pulley, C, cause the loaded boat, A, to ascend to the pile, B, to which the pulley is attached; and here it will be tied and remain until the pulley, C, has been shifted to the second pile. This is something that can be easily and quite quickly done in this manner:

One then begins by raising the wing, F, out of the water. After this, the men in the boat, E, easily cause the latter to ascend to the pile, B, by pulling the rope, D, by manual strength, or even, if it is desired, with a capstan. As soon as they have reached the pile, they detach the pulley, C, and carry it by land to the second pile, to which they fasten it and then begin to use it, first, for bringing up the boat, E, and afterward in order that the latter, in redescending, shall, as we have explained, cause the loaded boat, A, to ascend. In this way, with a few persons and little trouble and with much less expense than usual, the largest loaded boats may be made to ascend rivers; and in places where there are no piles to be found, the deficiency may be supplied by means of two anchors, which will be used one after the other.

IT is stated that 1352 trains arrive at and leave Chicago every day, about one-fourth being freight trains.

MACHINE FOR PREPARING TEST SPECIMENS.

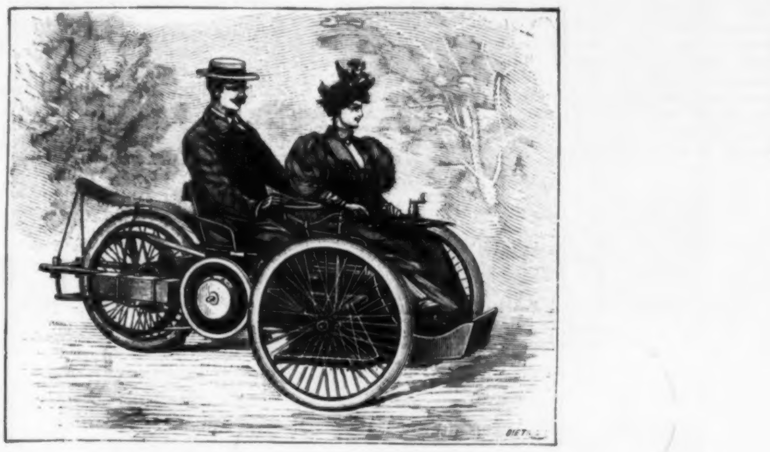
MESSRS. J. BUCKTON & COMPANY, of the Well House Foundry, Leeds, have introduced the machine illustrated herewith, for shaping at one operation both edges of plate strips so as to prepare them for testing, with a parallel portion 10 in. long and ⅛ in. narrower at each edge than the enlarged ends, which are left as the shears have cut them. This is, it may be stated, the form of specimen approved by Lloyd's and the Board of Trade. As will be seen, the machine consists of two cutter heads mounted on suitable headstocks attached at opposite ends of a suitable bedplate. The specimen is secured in a carriage which can be traversed between the two heads. There are eight cutters in each cutter head, not arranged uniformly as in a milling head, but arranged in such a sequence that one cutter acts as a pioneer, cutting off the first $\frac{1}{16}$ in. of depth; the others follow each $\frac{1}{16}$ in. deeper, and the last of the series finishes up the parallel part of the test piece. By this means a greater depth of material can be removed at one traverse of the work past the tools than could be done successfully with inserted cutters with uniform cutting edges. In this machine the cutter heads are carried upon an arbor passing through the driving spindle, and fitted with a nut both back and front. By this means the two cutting heads can be advanced toward each other, or set apart to suit whatever width of parallel part is required for the test piece. When set to the desired width they are firmly locked to the driving sockets by the nuts back and front. The machine in question was specially designed for the purpose of preparing plate strips for the testing machine in the year 1879 by Mr. Thomas Williamson, at that time engineer for the Steel Company of Scotland, and at present engineer for the Glasgow Iron and Steel Company, Limited. The machine has, it is stated, been found far more successful for this special purpose than any other form of milling or shaping machine, and has been supplied during the last fifteen years to many steel works in this country, on the Continent of Europe, and in the United States of America.—London Engineering.



TEST PIECE MILLING MACHINE.

THE BOLLEE AUTOMOBILE TRICYCLE.

THE citizens of Paris had an opportunity recently of seeing a small three-wheeled automobile vehicle skimming over the ground, evoluting with ease amid an entanglement of vehicles, and disappearing in a crowd of passers-by without any other noise than that made by the escape of burned gases. This apparatus, which the public, more and more interested in the question of automobile vehicles, watched with curiosity wherever it presented itself, is due to Mr. Leo Bollée, a manufacturer of Mans.



THE BOLLEE TANDEM TRICYCLE.

Mr. Bollée, after making trial trips of nearly 2,400 miles upon this tricycle, asserts that he traveled from Mans to Paris in seven hours, at a speed of eighteen miles an hour. Let us at once say that the automobile tricycle under consideration embodies no innovations in any of its parts, but combines within itself all the progress that the automobile vehicle industry has realized up to the present. It is no ordinary accomplishment for a manufacturer, in two months' time, to have devised and produced so simple and so strong a vehicle with the data furnished him by general experience.

The aspect of the Bollée tricycle is that of a very long and very low wagonette, quite pleasing to our eyes, which are as yet unaccustomed to such apparatus of locomotion. The slight elevation of the vehicle gives it a perfect stability, since its center of gravity is situated at but 16 inches above the surface of the ground. The stability is further increased by the relative width of the basal triangle (3·6 × 4 feet) and by the position of the steering wheels in front. The elongated form of the tricycle, which is very con-

ducive to speed, gives it a vague resemblance to a torpedo boat, and whoever has seen it shooting along at 30 miles an hour upon a level, and at 27 upon gradients, will recognize the fact the name of "road torpedo boat" is fully justified. The vehicle, in running order, weighs 350 pounds.

The motor is a gasoline one of four revolutions, as usual. It has but one cylinder, and that of very elongated form, in order that the expansion shall be as complete as possible. The burner is so combined that the flame shall return upon itself in a reverberatory.

The carbureter is the classic apparatus of Messrs. Panhard & Levassor. It will be remarked. upon inspecting the motor, that a practical mind has combined all its parts, has placed all the valves, for example, within reach of the hand, and, in a word, has reduced the gasoline motor to its simplest expression. This motor, according to tests that we have not been able to verify, makes from 800 to 1,200 revolutions a minute, and is of nearly 2½ horse power. It actuates the driving wheel, which is the hind one, through a belt, and not through a chain, as usual. Three gear wheels of different sizes allow the driver to obtain, as need may be, three different speeds, starting with 2½ miles an hour, and to ascend, even upon a muddy road, gradients of 10 to 100. The driving wheel is 30 inches in diameter and the two steering ones 34 inches. All three are mounted upon ball bearings and provided with Michelin removable pneumatic tires.

The accompanying figure gives an accurate idea of the Bollée tricycle. As may be seen, the person who sits in front does not aid in the steering of the vehicle. The steersman sits behind, his feet resting on each side upon a platform provided with a straw mat. He merely has to move his foot backward in order to press the lever of a powerful brake whose block is tangent to the circumference of the driving wheel. With his right hand he steers the vehicle through a hand wheel, which, by a very simple gearing, turns the fore wheels to the right or left; the steering, in fact, being done as in the Olympia tricycles used three or four years ago. With the left hand he holds an almost vertical lever which permits him, with a few motions, to effect several important maneuvers. If he pushes it forward, he tautens the driving belt and consequently starts the vehicle as soon as the motor has been set in operation through a winch, according to the well-known process. If, in the median position of the lever, he turns the handle to the right or left, he throws the motor into gear into one or another of the three speeds. Finally, if he pulls the lever backward, he loosens the belt and consequently suppresses the transmission, and, at the same time, presses the brake block against the driving wheel.

Upon the whole, this tricycle does not constitute an invention, but rather a combination of happy arrangements of inventions that are already known. We may add that it carries a supply of gasoline sufficient for a trip of 72 miles, that it may be run at an expense of scarcely more than a cent a mile, and that the price of it is low enough to place it within the reach of persons of moderate means.—La Nature.

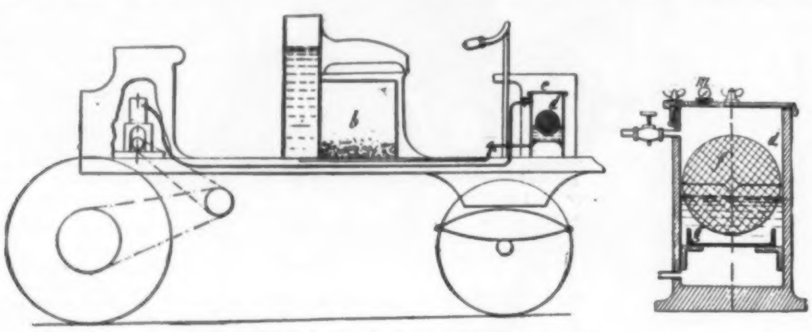
AUTOMOBILE ACETYLENE CARRIAGE.

Mr. Felix Richard has endeavored to apply acetylene to the propulsion of carriages and boats, and the accompanying figure gives a diagram of the arrangements that he has patented.

At a there is a water tank, back to back with which there is a receptacle, b, containing a supply of calcium carbide and forming, through its cover, a seat for the driver.

Two gas generators, d, closed by a cover, e, with a rubber joint, are placed in front. Each of these contains an openwork receptacle, f, divided by radial partitions into compartments filled with calcium carbide. This receptacle is traversed by a central axis provided at one of its extremities with a winch. Beneath, there is a pan that constitutes a receiver for the lime produced.

The water enters the gas generators at the base through pipes coming from the reservoir, a. While one is being charged, the other supplies the motor. Gages, m, show the pressure, which never exceeds a few centimeters of water. At the end of a certain period of operation, the calcium carbide receptacle is turned so as to put a new compartment in contact with the water.—Revue Industrielle.



AUTOMOBILE ACETYLENE CARRIAGE.

VIBRATION METERS.

Our illustrations give two views of an instrument designed by Mr. John Milne, F.R.S., which in its various forms has been used to record the vibrations and jolts which are experienced on railroads, locomotives and vehicles, and the elastic switchings and swingings of steamships and bridges. The principles involved in the construction of these instruments are those which are embodied in a modern form of seismograph, in which, although the frame of the apparatus may be subjected to rapid displacements, a certain portion remains practically at rest, and it is relatively to the steady points in the systems that motion is recorded. The parts of the instrument described as being upon the right hand side of Fig. 1 will be found upon the left hand side of Fig. 2, and vice versa. On the right of Fig. 1 is a clock driven by an unusually strong spring and adjustable in its rate of movement by means of a fan. A grooved India rubber roller, clearly shown in Fig. 2, geared to the clock, draws a band of paper from a large roll over a drum on which the writing points of the instrument rest. On account of the rough usage to which these instruments may be subjected, these clocks have to be specially constructed. The clock is started, and the writing indices, which in this case are pens fed with ink, lowered upon the paper by depressing the small rectangular plate which is best shown attached to the clock frame in Fig. 2. To stop the clock and lift the pens from the paper, the small lever shown in a nearly vertical position near to the starting "press" is momentarily pulled backward. On the left hand side of Fig. 1 a small pencil rests in an inclined position upon the paper running over the top drum. At known intervals of time, say every five seconds, or after known distances have been run, as for example at quarter mile posts which may be passed when testing the movements of a locomotive, this is depressed and a mark is made. Among other things the intervals between these marks enable the observer to make very accurate determinations of the period of the vibrations which are being recorded.

If we know the period of a vibration, and measure its amplitude on the diagram, we are then in a position to state with accuracy the maximum acceleration which has been experienced, and to determine in practical units the jerks tending to break a drawbar or a coupling.

When testing a railway track, instead of running paper at a rate of 1 ft. or 2 ft. per minute, and obtaining an open diagram as shown in Fig. 2, experience has shown that paper running at a rate of 1 ft. or 2 ft. per hour is amply sufficient. If the diagram is coiled upon a drum (not shown in the figures), not only does the instrument become more bulky, but the record is quickly hidden after its formation. For those reasons it has been found preferable to allow the paper to fall freely into a box or case. Another attachment (also not shown in the figures) is a pencil or punch which marks the paper after every 100 revolutions of one of the wheels of the carriages in which the instrument is placed. With a diagram thus marked a stranger to the line on which he travels is enabled to say that certain irregularities, as shown by excrescences on the general diagram, were formed at certain definite distances from known stopping or starting points. An inspector who is fairly well acquainted with his line can usually locate the position of such irregularities without the aid of these marks, which he sees from the diagram occurred after the train had been so many minutes and seconds on its journey. He knows the average speed of the train from the time it took in running between certain points of stopping. The apparatus which records the vibrations is best shown in Fig. 1, on the right hand side of which is a coiled spring kept in its wound position by the moment of a lever carrying a round brass weight. For vertical components of motion this weight is practically a steady point, and as the frame carrying this moves up and down, the vertical pointer behind the spring carrying the pen moves from side to side.

Next to this, on the left, is the apparatus for recording horizontal motion parallel to the length of the machine. This consists of a large cylinder pivoted near to its upper edge, the swing of which is controlled by a lower but smaller cylinder to which it is freely linked, pivoted on its lower edge. A little consideration shows that these two cylinders may be so proportioned that if they are displaced, for example, toward the right, the moment of the upper one tending to cause it to return to its normal position may be so far controlled by the lower cylinder tending to fall outward, or still farther toward the right, that the moment of restitution may be made as small as desirable.

For a quick right and left motion of the frame there will, therefore, be an axis lying between the axes on which the cylinders move, which is practically at rest. A pointer and pen projecting upward from one of these cylinders therefore records motion relatively to this steady line.

In a complete apparatus a piece of apparatus similar to this latter, but placed at right angles to it, would be required. The apparatus as shown may, for example, be used first to record the transverse swing of a carriage or bridge, and then, by turning it through 90°, to record the longitudinal motion.

Levers for clamping the moving parts of these instruments when not in use or being carried are shown in Fig. 1. The longer the pointers are, the more is the multiplication of the actual motion. The figures show an apparatus suitable for recording the elastic vibrations of torpedo boats and bridges. To record the rapid minute motions produced, for example, by machinery in a building, still greater sensibility is required, while for the rough and sudden displacements we meet with on railway lines, the multiplication of the writing indices must be reduced and excessive displacements be met by specially contrived frictional resistances. From this it may be gathered that specially designed instruments are required for special purposes. For indicating the general condition of a railway line, an instrument which only records one component of motion (vertical or transverse) by means of a pencil or style upon a band of paper only 2 in. in width is sufficient. The actual width of a diagram thus obtained varies with the position the apparatus occupies in a train, whether it is in a carriage or on a locomotive and with other conditions; but the irregularities due to abnormal motions at facing points, changes in gage, want of ballast, at entering and leaving bridges, whatever may be the actual size of a diagram, stand out as excrescences.

Diagrams of this description have been taken in many parts of the world, the longest being those which have been taken from ocean to ocean across the American continent. In Japan these instruments have shown faults, as, for example, in sleepers which were internally rotten. These had externally the appearance of being perfectly sound, and had repeatedly escaped the attention of inspectors.

For locomotives the component of motion which, if pronounced, means, among other things, loss of power and an undue consumption of fuel, is the horizontal

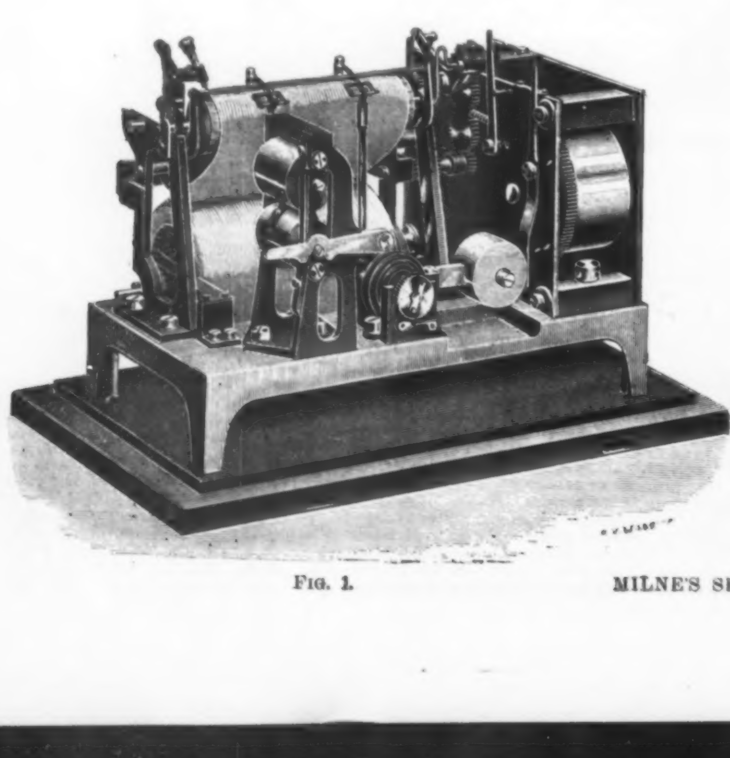


Fig. 1.

Fig. 2.

MILNE'S SEISMOGRAPH.

fore and aft motion. By getting rid of this—and the extent to which it exists is shown by records from vibration meters—certain lines in Japan have effected marked savings in fuel, workshop repairs have decreased, locomotives have been made to run safely at very much higher speeds, and for very much longer distances without steam than they were capable of when delivered by the makers. The sooner that the vibrations of locomotives are subjected to close examination by vibration meters or other means, the sooner will engineers see how far the present practice in balancing, which differs widely in different shops, may advantageously be modified. It is more than unlikely that all the methods are correct, and some of them, which no doubt can be supported by pages of figures, result in such abnormal tugging that it seems dangerous to remain upon the foot plate. A somewhat similar remark applies to torpedo catchers and high speed steamships. That a large motion exists in many of these vessels there is no doubt, but whether this has been measured with sufficient accuracy for practical purposes is, when we hear of specifications which allow of rapid vertical displacements almost sufficient to project bodies upward, a matter open to great doubt. In addition to giving an automatic report of the motion of a locomotive, or the state of a line which those at headquarters can but rarely, if ever, inspect in person, a vibration meter times a train and gives the duration of its stoppages. Its most important function is, however, to record those movements which result from imperfection in a track or rolling stock, and cause discomfort to the traveling public, and which, when violent, suggest the possibility of derailment, and imply a waste of power and wear of valuable materials.

AUTOMATIC BREECH MECHANISM FOR QUICK FIRING GUNS.

MONSIEUR G. CANET, whose name is so closely associated with the development of gun manufacture in France, has recently introduced a new form of breech mechanism, especially adapted for quick firing guns, and which possesses so many novel details that a description of its arrangement will be read with interest. Before referring to the latest pattern on this system which M. Canet has produced, says the London Engineering, to which we are indebted for the cuts and copy, we may say a few words about a comparatively recent patent that contains the first ideas on which the new method of breech loading is founded. The views, Figs. 1 to 4, are taken from a patent dated May, 1894, and the leading idea described in the specification is as follows: A spherical breech block is employed, which has an aperture extending through it in such a direction that by turning the block on an axis transverse to the bore, it will open or close the breech, and which block is so constructed that a cartridge inserted through the aperture into the gun can be forced home by the surface of the block in turning the same to close the breech. On referring to the engravings, Figs. 1 to 4, it will be seen that the block, B, is contained in a seating, formed partly in the gun, and partly in the ring, D, which is screwed to the rear of the gun. In this position the block has an angular displacement of about 90 degrees, the movement being limited by the stop, E. The block is actuated by a horizontal shaft, H, and a handle, H1, at the side of the gun; the motions of this handle in one direction or the other serve to open and to close the breech respectively. The cartridge is introduced through the opening in the block, which, when in the loading position, is axial with the bore of the gun, and the act of inserting the cartridge sets the extractor mechanism in position.

From this early form the latest type illustrated by Figs. 5 to 7 has been evolved. The breech mechanism consists chiefly of a block formed, as regards the front portion, by a spherical surface, on the sides by two planes, and at the rear by a concave semi-cylindrical surface. The plane faces are grooved with a series of concentric threads that may have either a triangular or a square section. In the breech of the gun a corresponding seating is cut parallel to the axis of the bore, to receive the block and its two lateral faces; it has, therefore, a series of concentric grooves similar to the threads on the block. When the breech is closed the block fits exactly to seating in the gun, and offers ample resistance to the powder pressures. A bent lever is either bolted to or forged on the block. The longer arm of this lever is straight, and moves in a vertical plane on the right hand side of the gun; the short arm is of a semi-cylindrical shape, and moves to and fro in a recess formed in the rear face of the gun. The axis of the semi-cylinder passes through the centers of the two series of threads and concentric grooves; it is, therefore, around this axis that the oscillating motion of the block, in opening and closing the breech, is produced. These two movements are limited, the first by a stop set in the upper part of the seating in the gun, and the latter by a special screw, the nut of which projects from the long arm of the lever. The length of this screw is greater than the depth of the nut, so that when screwed to the bottom of this latter it projects slightly beyond the inner face of the lever. The end of the screw that thus projects enters a circular groove cut on the right side of the gun. The length of this groove sets a limit on the range of travel of the lever, and at the end it corresponds to the extreme open position of the breech. On the end of the longer arm of the lever slides a handle provided with a lateral tooth, which fits a corresponding recess cut in the side of the gun. Within the handle is a coiled spring which, when the breech is closed, presses the tooth into the recess, and thus prevents the breech from moving until after the gun has been fired. The charge can be exploded either by percussion or by an electric fuse, or by both combined. In the first method, which is shown in the illustrations, a "repeating" device is used, that is to say, a device by which the same fuse can be acted on several times without changing the position of the breech. It consists of a striker controlled by a V shaped spring and actuated by a detent with two branches, one of which carries a ring to which is attached the firing cord. These various parts, except one arm of the detent that is visible in the illustration, are mounted in a recess formed in the block. So long as the breech is not completely closed, the detent is fixed, and premature firing cannot take place. The cartridge cases are removed from the gun by means of a four armed extractor, which is placed in a recess in the gun. It is operated by the breech block itself, which bears against the two short arms of the extractor levers at the end of the opening movement, and depresses them by its weight. To open the breech it is sufficient to press the handle on the lever and disengage the safety tooth already mentioned. The lever is then released, and as the center of gravity of the block is located in front of its center of oscillation, the breech opens automatically by reason of its weight alone. This movement is very rapid, because the block has only to make an angular movement of 90 degrees to open the bore of the gun completely. In this movement the rear semi-cylindrical portion takes a horizontal position, and at the end of the motion it forms an extension of the powder chamber and thus acts as a carrying table for the cartridges, which is a very considerable convenience when serving the gun rapidly. The arrangement is also convenient for the ejection of the cartridge cases.

To close the breech, a reverse motion is given to the lever, and as soon as it is thrown over the safety catch enters the recess and the breech is shut. The breech block and its accessories consist of five parts in all; these can be taken apart and reassembled by hand with great facility and with but little loss of time. The operation of dismounting is as follows: The nut that works in the circular groove is run back, and the lever, thus set free, is turned through 180 degrees; the block is then entirely independent of the gun, and can be removed for cleaning or inspection, or to replace an extractor, or the firing mechanism. In its present form this very ingenious arrangement has been tested at the gun factory of the Forges et Chantiers Company, at Havre, and has been found to give very satisfactory results. The advantages that are claimed for it, judging from the experiments made, are as follows: The mechanism is extremely simple and rapid in its operation, and is maneuvered by a single motion of the lever. The opening of the breech is entirely automatic. The mounting, dismounting, and examination are of a very simple character; there is absolute safety in working. There are no projecting parts in the way of the men serving the gun. All the parts of the breech are well protected by the gun itself, and there is nothing projecting at the time the gun is being loaded. The number of parts is smaller than in any other arrangement of breech closing mechanism, being reduced to four, when an electric fuse is employed,

Fig. 1.

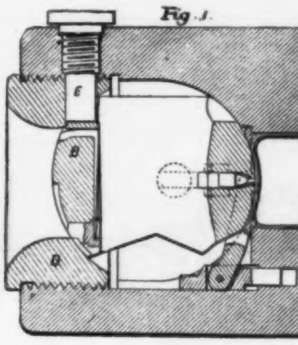


Fig 2

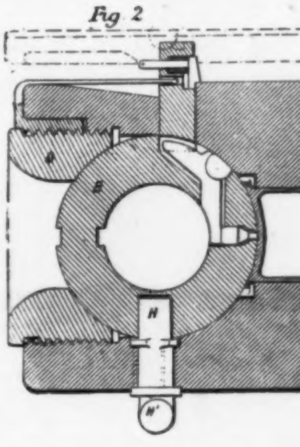


Fig. 3.

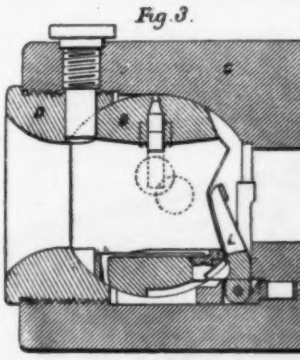


Fig. 4

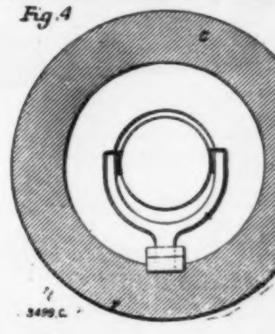


FIG. 5

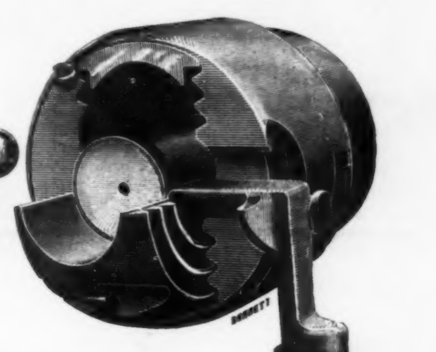


FIG. 6.

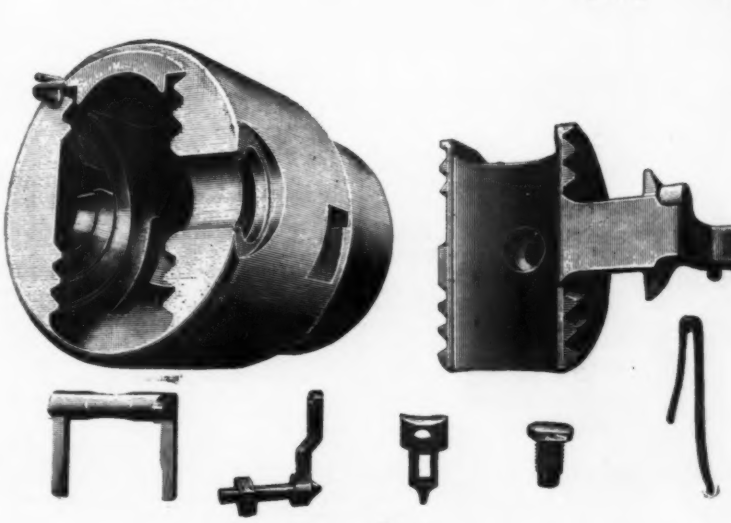


FIG 7.

AUTOMATIC BREECH MECHANISM FOR QUICK FIRING GUNS.

and to five in the case of percussive firing. The illustrations show the arrangement in full detail. We shall look forward with interest to the further experience that will be made with this highly ingenious device, and to the improvements it will yet doubtless receive at the hands of M. Canet.

THE YRTYCHE BRIDGE ON THE TRANS-SIBERIAN RAILWAY.

THE Yrtyche bridge, which was opened for traffic at the end of March, 1896, is one of the most important structures on the Transsiberian Railway. For the masonry there were employed 8,770 cubic meters of granite, brought from the Oural all dressed for the facing and coping. The interior of the abutments and piers is of rubble brought from Semiiarsky and Delousky, localities situated upon the Yrtyche at a short distance from Semipalatinsky. Of this there were used 9,711 cubic meters, with 7,930 tons of Portland cement derived from the Gloukhoozersky manufactory, near St. Petersburg. The abutments have the dimensions mentioned below, the numbers running from the left to the right bank.

The total height of the lower part of the caisson (the edge) to the upper part of the blocks that support the trusses is:

1	2	3	4	5, 6, 7
31·790	33·711	33·070	32·857	32·857

The depth beneath the level of the soil is:

1	2	3	4	5	6	7
17·282	15·788	14·508	15·575	14·082	14·508	13·015

The starlings form an angle of 45 degrees with the level of the water. The construction of the foundation was effected by means of compressed air with iron caissons embracing the abutments and piers to a height of:

1	2	3	4, 5, 6	7
13·335	14·402	13·762	13·548	12·268

Two diving bells served for the entrance and exit of the laborers and materials. A single compressor actuated by a 15 horse power engine was employed for the two bells of each caisson. An auxiliary 6 horse power engine was used for the removal of the spoil.

The total weight of iron employed was, for the caissons, 491 tons, and for the spans, 3,636—say in all 4,127 tons, which came from the Votkine works upon the Kama. The girders were assembled at Oufa in the establishment of Contractor Berezine, and were carried to Ousk, upon the left bank of the Yrtyche, by railway. The span trusses were mounted in situ by means of scaffoldings. The riveting was all done by hand, partly at Oufa and partly at Ousk. It took, on an average, about twenty-five days to mount the spans.

The amount of earthwork required upon the right bank was 92,170 cubic meters, and upon the left bank, 18,454 meters. The sustaining walls and the facing of the earthwork took 3,885 cubic meters of granite rubble. For the right and left embankments, it required the digging of 412,246 cubic meters of earth.

The net cost of the earthwork was 280,000 rubles,

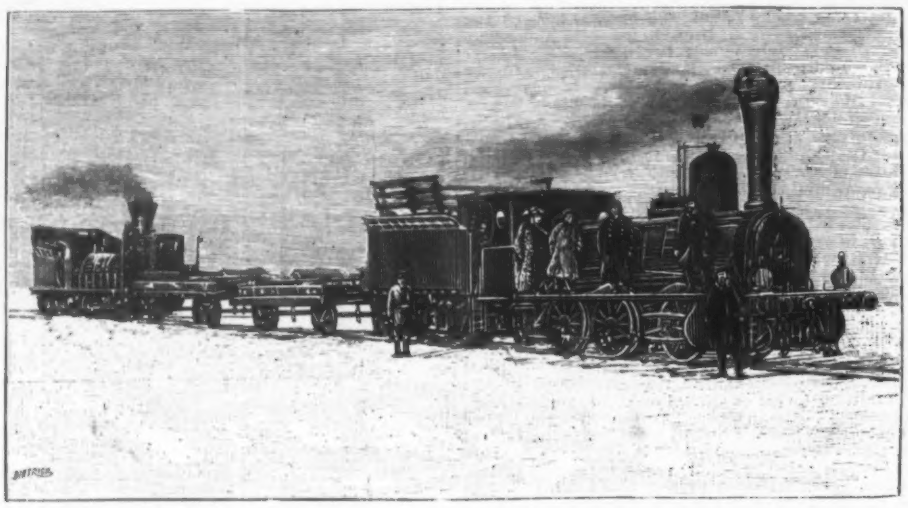


FIG. 1.—TRAIN LOADED WITH RAILS FOR THE TRANSSIBERIAN RAILWAY.

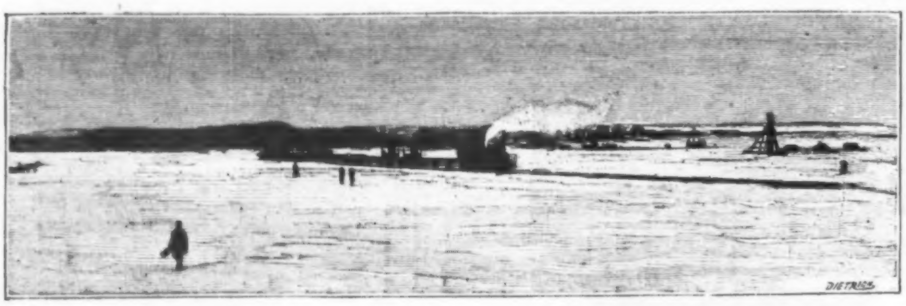


FIG. 2.—TRAIN LOADED WITH RAILS CROSSING THE YRTYCHE.

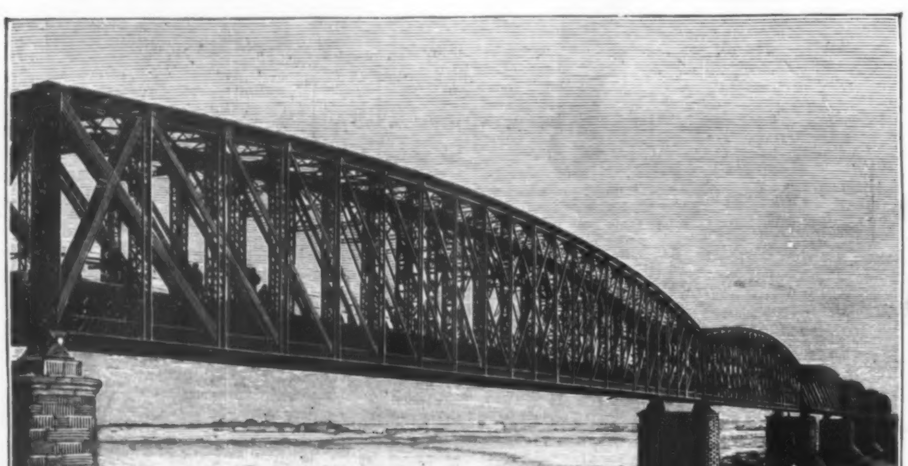


FIG. 3.—VIEW OF THREE-QUARTERS OF THE YRTYCHE BRIDGE.

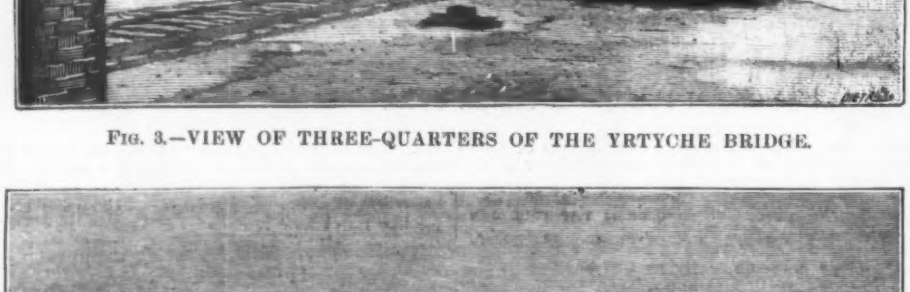


FIG. 4.—GENERAL VIEW OF THE YRTYCHE BRIDGE.

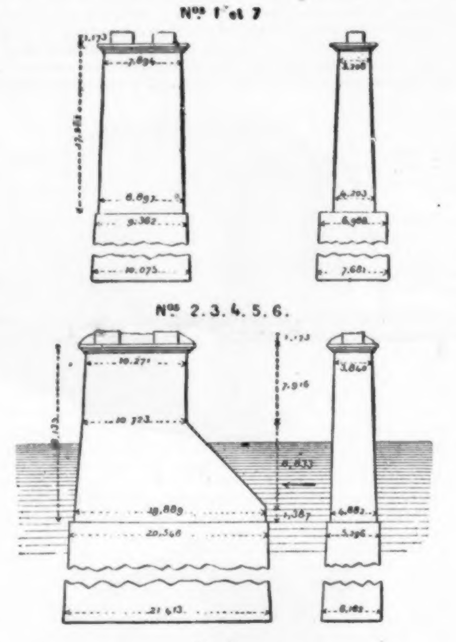


FIG. 5.—DETAILS OF THE PIERS.

that of the masonry 1,100,000 rubles, and that of the caissons and spans nearly one million rubles.

The caissons were mounted, No. 1 (abutment) upon the left bank, No. 2 (pier) and No. 7 (right bank) upon the ice during the winter of 1894-95. After the assembling, there were constructed for the engines and masonry large sheds in which, in special compartments, the rubble and facing stones were heated by means of steam. These, besides, were raised to the desired temperature by means of portable sheet iron stoves filled with coal, since the cement refused to set upon the cold surfaces.

Nos. 3 and 4 were mounted upon land at the edge of the Yrtyche. At the period of high water, the latter lifted them and allowed them to float to their destinations. No. 6 was mounted upon two connected boats that carried it to its proper place. No. 5, the last one mounted, was carried to its destination upon piles, which were afterward removed in order that it might be sunk.

The construction of the abutments and piers was effected in pairs (save in the case of No. 2) and was begun November 1, 1894. In measure as two neighboring piers were finished, scaffoldings were erected, and the mounting of the trusses was proceeded with. The rails were carried by trains (Figs. 1 and 2).

The finished bridge presents two sustaining walls, two abutments and five piers (Figs. 3 and 4). The wide spans are 106·68 meters in length and the smaller ones 23·47 meters. The superstructure has a width of 4·877 meters. Each span is independent of its neighbor and rests at each extremity upon two rollers. The transverse girders rest upon rollers of small size.

The width of the Yrtyche at the point where the bridge crosses it is 746·75 meters. It was found advantageous to have but six spans, and to replace the seventh by a continuation of the embankment of the right shore, this effecting a saving of 150,000 rubles.

The work of mounting, which was begun July 15, 1895, was finished February 23, 1896. The bridge, freed from its scaffoldings March 1, 1896, was submitted to the regulation tests on the 15th and 16th, and is now open for traffic. The tests were made by Prof. Belelioubsky. Fig. 5 gives the details of the piers.

We must add that the pressure in the caissons reached two and a half atmospheres. The workmen, to the number of forty in each caisson, worked therein six hours. The area of the base of the pier caissons is 100 square meters, and that of the abutment caissons 63 square meters. The descent took place at the rate, on an average, of 60 centimeters in 24 hours. The weight of the abutment caissons is 40·95 tons and that of the pier caissons 81·9 tons. They rest upon a stratum of dark green plastic clay. The embankment of the left shore is 700 meters in length and that of the right, which extends to Ousk station, 1,800 meters. The difference of level between high and low water is six meters. The distance between the highest water and the bridge girders is eleven meters, this being sufficient for the passage of steamers and barges.

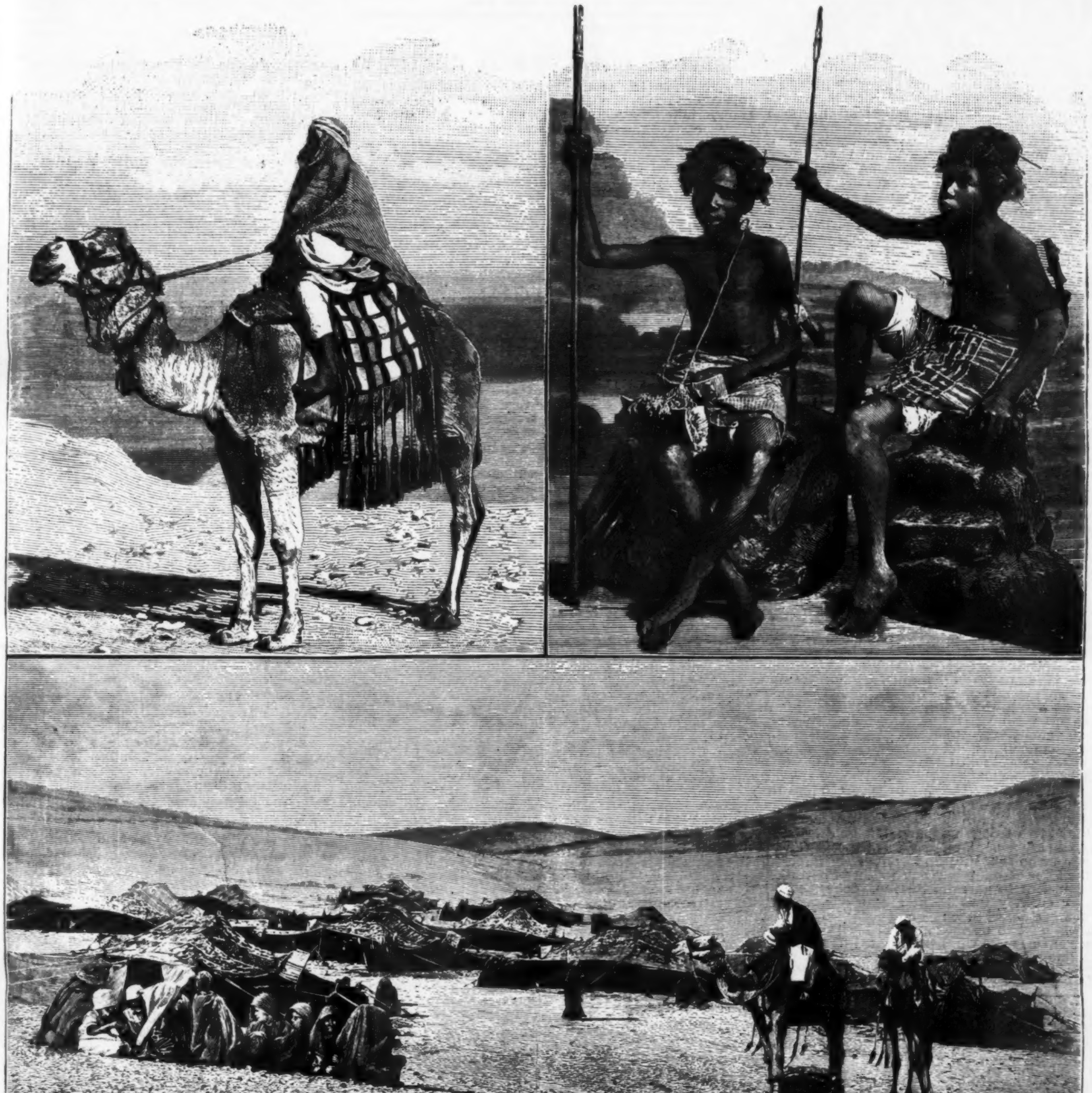
The volume of water of the Yrtyche is 6,000 cubic meters a second under the bridge. The work was executed by Engineer Malignesky, intrusted with the power of contractor under the surveillance of Engineer in Chief Zalousky, and especially of Engineer Olchevsky.—La Nature.

Women employed in the laundries of Vienna have to work from five in the morning to nine, ten, or even twelve at night, for which they get $2.50 a week and their meals.

THE SOUDAN CAMPAIGN.

FORTUNE continues to smile upon the Egyptian, or British-Egyptian, expedition up the Nile, whose ostensible object is the recovery to the Egyptian government of that stretch of country to the south of Wady-Halfa which was surrendered to the control of the Mahdists at the close of the fruitless campaign of 1884. The early successes at Suakin, and later at Akasheh, have been followed by a more serious encounter, in which the native troops again showed remarkable firmness and dash. The Dervishes, it is said, on the other hand, do not fight with the same old fire and reckless bravery which formerly made their charge perilous for the picked troops of the English army. It would seem as though the fierce religious enthusiasm is wanting, and that the present leader has not the hold upon the faith and imagination of his followers which characterized the celebrated Mahdi of 1884.

A correspondent to the London Times, writing from the front, says: "In the course of many conversations with two sheiks of Ababdeh I have contrived to acquire some insight into their true opinions on the situation in the Soudan, and these no doubt represent the views of the great majority of the inhabitants of the country. The disappointment will be bitter indeed if the British and Egyptian troops do not now bring the Khalifa's reign of terror to a close. The Ababdeh sheiks, who are in constant communication with their numerous relatives and fellow tribesmen dwelling south of the frontier, and consequently subject to the Khalifa, are kept very well informed as to all that is going on in the Mahdist country, so that their statements carry weight. On one occasion Ahmed spoke thus: 'Mahdism is quite dead. The reconquest of the Soudan should not be difficult. There are no Mahdists now. All men in the Soudan know that Mohammed Ahmed was no Mahdi, for was he not vanquished in battle and did he not die of disease like other men! Abdullah el Taaisha himself no longer says he is the Khalifa of the Mahdi, but styles himself the Sultan of the Soudan. The Khalifa cannot hold himself forth as a holy man; he has no religion; he does things that no Mussulman would do, that no Jew would do. All men detest him, for he breaks every ordinance of our religion. Wherever he goes he seizes by force the young girls, many of them daughters of our best Soudanese families, and sends them to his harem. He casts them forth as soon as he wearies of them, and he has now 170 children.' On being asked whether the Khalifa still considered his position unassailable, Ahmed Bey replied: 'He fears that his end is near; he knows that his friends are few. So he now keeps within the palace precincts at Omdurman 500 camels always prepared for a long journey. In case of disaster befalling his armies, he hopes to load these camels with his treasures and to escape to his own mountains with the favorites of his household. But it is unlikely that he will succeed in



1. Ababdeh Arab from the district of the wells of Mourad. 2. Auxiliary troops north of Suakin. 3. Encampment of Nubians near Wady-Halfa.

ANGLO-EGYPTIAN EXPEDITION INTO THE SOUDAN.

this, for his people will stop him when they discover his intention, and there are many men of his own Baggara tribe who will have no scruple in killing him in order to possess themselves of his wealth.'"

An important step, both in itself and in the possibilities which it suggests, is the reinforcement of the Anglo-Egyptian army by a contingent of the native Indian troops from British India. The immediate effect has been the transference of that portion of the native Egyptian army which was engaged in the operations at Suakin to the Soudan, its place being taken by the Indian troops. Altogether, there are about 12,000 Egyptian and Soudanese troops of all arms at the front, the base at Wady-Halfa being kept by the first battalion of the North Staffordshire regiment, which is about 800 strong. It is reported that the army of invasion, or more correctly, reconquest, is to be strengthened by the addition of 5,000 British troops which will be sent out in the fall. The fact that the military authorities speak of this as a "stiffener" would indicate that their confidence in the native soldier has yet to be fully established.

The situation is critically discussed by its military correspondent in a recent issue of the London Daily Graphic, who says that if the report of an intended advance on Berba is correct the operations are to be more extensive than the mere recapture of Dongola, as originally announced, would have indicated. He further says: We are now informed that Dongola is but the first step in what must eventually lead to the complete reconquest of the Soudan—a view more than once put forward in these columns—and the ultimate and, indeed, the immediate object of the present advance is not Dongola, but Berber—a place second only to Khartoum in political and strategical importance. Berber lies, as may be seen by reference to a map, considerably south of Abu Hamed, the point at which the Korosko Desert route strikes the Nile, and but a little below the junction of the Atbara with the greater rivers. It is, indeed, little more than 200 miles from the capital and center of the Soudan, and with it in our hands, and secure communication with Suakin, but 260 miles away, we should be within easy striking distance of Khartoum, the only obstacles to whose fall would then be military and no longer geographical.

The programme as sketched out for the autumn campaign is that, once the concentration of the Egyptian army at Akasheh is completed—which it soon will be by the arrival of the troops set free from Suakin—an advance will be made to Mograkeh and Suardeh, now held by the Dervish outposts, in order that the line which is to circumvent the numerous cataracts that lie north of Hannek may be pushed on a further stage. The resistance at these outposts will doubtless be overcome, and then a further short period of comparative inaction must ensue while the railway is being constructed and other communications consolidated. This series of short advances, such as have already taken the troops to Akasheh and Ambigol, will continue until Hannek, at the top of the Third Cataract, and about forty miles from Dongola, is reached—which may be expected about the end of July.

From this point the river is devoid of obstacle for about 240 miles, up to the Cataract of Barkat, beyond Korti, and only about 100 miles lower than Abu Hamed; but some considerable opposition may reasonably be expected ere this advanced point is attained, seeing the importance and fertility of the Dongola province and its comparative proximity to Khartoum. While the river column advances along this open water and the much more difficult stretch that lies between Barkat and Abu Hamed, an advance is—if the statement is to be believed—to be made in the direction of the latter place from Suakin. The troops engaged are to be British and Indian, and it is probable that the Mediterranean garrisons will supply the British contingent. That the native troops now arriving at Suakin from India could advance alone, as seems to be conceived by some writers on this subject, is obviously impossible, since the force contains but two infantry battalions—about sufficient to garrison Suakin, Tokar, etc., but obviously entirely insufficient for an advance of 260 miles across a desert in which an enemy led by Osman Digna will have to be reckoned with. Doubtless the advance of this force will be facilitated by that of the river column, and probably the movements of the two will be so timed as to bring them simultaneously to Abu Fatmeh, although the arrival here and further advance on Berber is scarcely likely to take place so soon as the somewhat sanguine estimate of the end of August or beginning of September indicated in the statement above mentioned.

This programme reads very well on paper, and we are taken easily enough over both the military and geographical obstacles which may reasonably be expected between Akasheh and Berber, but it is obvious that the ease and rapidity of the advance depend entirely upon the opposition offered, and the constitution and numbers of the force employed upon the Nile, which is the column on which the main burden of attack will fall. The troops at Sir Herbert Kitchener's disposal on the river consist of some thirteen infantry battalions, together with a few squadrons of cavalry, a battery or two of artillery, and some camel corps. These will have behind them one British regiment—the South Staffordshire—and will be supplemented above the Third Cataract by three armored sternwheel steamers armed with quick-firing guns.

The distance from Wady Halfa—the present base of the expedition—to Abu Hamed is nearly 500 miles, and as Dongola has to be captured and garrisoned, and such points as Old Dongola, Debbeh, Ambukol, Korti, Abu Dom, etc., on the exposed left bank of the river, must be strongly held against the arrival of forces from Khartoum coming by the Bayuda Desert routes, it is very doubtful whether the troops at General Kitchener's disposal would be sufficient for the enterprise, even were they British and not Egyptian. "According to information received," we are told, "the impression prevails at headquarters in London that, owing to want of provisions and ammunition, the Dervishes will offer but a feeble opposition to the expedition, especially as regards Dongola."

The advance into the Soudan is just what is wanted to unite the scattered Dervish tribes, for if they have internecine quarrels of some depth and seriousness, they hate the white man more than their black brothers, and the idea of Egyptian rule is repulsive to them. Already it is reported that the Khalifa has made friends with his rival Sherif, and that the latter is coming to Khartoum with his fighting men. And it must be remembered that even if no great opposition need be expected this side of Dongola, it is beyond Dongola that the real difficulties commence, and it is on the advance to Abu Hamed that the column will be most exposed, while the taking of Berber will be a far greater exploit than the occupation of Dongola. It is to be hoped, therefore, that before the final advance takes place in the early autumn a sufficient force of British troops may be sent out, not only to Suakin to share the advance across the desert with the Indian contingent, but to the Nile itself, to fight side by side with Sir Herbert Kitchener's Egyptians and Soudanese, as to whose capabilities for the serious task now before them very doubtful opinions are openly expressed by those who know them best.

We are indebted for the accompanying illustrations to Le Monde Illustré.

CHEMICAL ACTION OF HEAT AND LIGHT.*

AT a meeting of the French Chemical Society, M. Lemoine spoke of a series of experiments which he had undertaken to compare the effect of light and heat by means of the same chemical reaction. Bunsen and Roscoe have published some papers on the same subject, but Lemoine paid especial attention to selecting his reaction so that the same one could be applied to both. He selected a mixture of oxalic acid and ferric chloride, which is easily acted on by light in the cold and by heat in the dark. The liquid decolorizes, gives off carbonic acid and forms ferrous chloride:

$$Fe_2Cl_6 + C_2H_2O_4 = 2FeCl_2 + 2HCl + 2CO_2.$$

In the sun the gas is formed quite rapidly. Exposed to the electric light the action is very much slower. Solar light, either clear or reduced by various screens, was used by the author exclusively.

The proportion of the mass decomposed in a given time—that is, the ratio of the decomposition effected to the decomposition possible—is easily measured by the amount of carbonic acid given off or the amount of ferrous chloride formed. To measure the gas it may be collected over glycerine, in which it is practically insoluble. It is better to determine the ferrous chloride by titration with permanganate.

Action of Heat on the Mixture.—At a given temperature the rapidity of the action decreases as the mixture changes, but it is proportional to the existing active components at such time. Variations of temperature considerably affect the rapidity of action, as with almost all other chemical action. On comparing different strengths of solution, it is found that an excess of water accelerates the action; this is due to the decomposition of the chloride by water.

Action of Light.—Some preliminary experiments showed that the action was very slow in yellow light and quite rapid in blue light; neither violet nor ultra violet exerted any strong modifying effect. Suppression of light caused the action to stop quickly, or if there was any action it was so faint as to be imperceptible. By the aid of long calculations the author establishes the relation between the absorption by the reagent and its decomposition, and then the quantities decomposed in the first moments of reaction. These same formulæ may be used to determine the intensity of solar light, by using as a unit a certain amount of matter decomposed under certain standard conditions as to light, heat, etc.

Conclusions.—Chemical action produced by light or by heat follows the same laws. According to an idea of Berthelot, light serves only to promote the temperature at which the action would take place, or more exactly, it accelerates an action which would take place without it only in an almost infinite time. The calculations follow results of experiments. We can calculate what will occur in a decomposition of a certain given kind, in a vessel of a specified form with a definite light and heat strength or the reverse. The conclusions apply to solar light, but a method of investigation is shown which may be applied to others.

PRESSURE OF ANHYDROUS AMMONIA.

SOME time ago we had occasion to elaborate a table showing the pressure of anhydrous ammonia at different temperatures, and as it appears to be somewhat more correct than those we have seen so far, that portion of it which is of most practical value is given below.

Temperature Degrees Fahrenheit.	Pressure of Ammonia in Pounds.	Temperature Degrees Fahrenheit.	Pressure of Ammonia in Pounds.
30	63	75	142
35	70	80	154
40	77	85	167
45	85	90	182
50	93	95	199
55	102	100	218
60	111	105	240
65	121	110	266
70	131	115	296

—West Brewer.

Cold Process for Preserving Fruit.—The fruit must be sound and clean and may be washed if desired. It should be packed tightly in jars or crocks, taking care, however, not to injure the fruit. Take two ounces of salicylic acid and 25 pounds of sugar (coffee C is recommended) and dissolve in six or seven gallons of hot water. The salicylic acid dissolves with great difficulty. The solution should be made up in a porcelain lined kettle. When all is dissolved allow it to get cold and then pour on enough of the solution to thoroughly cover the fruit. If any fruit rises, it should be removed. It is a good plan at first to weigh the fruit down lightly with a piece of glass, as it is absolutely essential at all times to keep the fruit under the liquid, as, if any floats, it is liable to spoil and to contaminate the rest of the fruit. The fruit should be kept in a cool, dry place, and should be kept covered, but need not be sealed. Some physicians consider fruit so preserved to be unhealthy.

* Translated and abstracted from the American Journal of Gas Lighting from the original paper as published in the November number of the Annales de Chemie et de Physique.

SELECTED FORMULÆ.

To Lighten the Hair.—

Golden Hair Dye.—Hair is generally turned to a golden hue by the application of a solution of peroxide of hydrogen. It will require to be used about once a fortnight. Washing the hair in solutions of soda or borax also tends to lighten the color, but it should not be done too often, or the hair may become coarse and tow-like.

For Gray Hair.—

Restoring Pomade.

Lead acetate	40 grains.
Precipitated sulphur	60 grains.
Glycerin	1 drachm.
Balsam of Peru	45 grains.
Beef marrow	2 ounces.
Castor oil	4 drachms.
Perfume	10 drops.

Rub the sulphur and the acetate of lead together in a mortar, then add the glycerin, balsam Peru, and perfume, lastly the marrow and castor oil, which have previously been mixed by melting the marrow on a water bath. Stir well until perfectly mixed. Preparations containing lead should be used with care.

A lotion having the same effect may be made as follows:

Restoring Hair Wash.

Precipitated sulphur	20 grains.
Lead acetate	60 grains.
Glycerin	1 ounce.
Eau de Cologne	4 drachms.
Distilled water	8 ounces.

Rub the sulphur and the acetate of lead well together, then add the glycerin, and lastly the water and eau de Cologne. Shake the bottle well before using. The pomade or lotion may be used twice a week until the desired effect is obtained. After that, an occasional application will be sufficient.

For Falling Hair.—

Deodorized petroleum, perfumed by adding two drops of perfume to each ounce. A little should be rubbed into the scalp night and morning.

Stimulating Hair Wash.

Ammonium carbonate	30 grains.
Distilled water	10 drachms.
Tincture cantharides	2½ drachms.
Eau de Cologne	10 drachms.
Rum	7½ ounces.
Oil of lavender	2 drops.

Dissolve the carbonate of ammonia in the water, mix the other ingredients together, and add.

Quinine Hair Wash.

Sulphate of quinine	8 grains.
Eau de Cologne	2 ounces.
Bay rum	2 ounces.
Glycerin	2 drachms.
Rose water	3½ ounces.
Alcohol	4 drachms.

Dissolve the quinine in the eau de Cologne, alcohol, and bay rum, and add the glycerin and rose water gradually.

For Stimulating and Cleansing the Scalp.—

Cleaning Hair Wash.

Almond oil	4 drachms.
Ammonia water, 10 per cent	6 drachms.
Spirit of rosemary	1½ ounces.
Eau de Cologne	1½ ounces.
Tincture saffron	2 drachms.

Mix the oil and ammonia, shaking well, and then add the other ingredients. To be shaken before use.

Rosemary Hair Wash.

Powdered borax	30 grains.
Tincture cantharides	1 drachm.
Spirit of rosemary	4 drachms.
Camphor water	5 ounces.
Rose water	2½ ounces.

Dissolve the borax in the water, and add the other ingredients.

Old-Fashioned Root Beer.—In the days of makeshifts there are few housekeepers who take the trouble to make root beer from the roots and herbs of the forest, as our pioneer ancestors did. This is a wholesome and most excellent cooling drink for the hayfield, and costs literally nothing if there are bottles in the house to bottle it and a cask to mix it in. Gather in the woods two pecks of wintergreen leaves and stems. The old leaves may be used as well as the new ones. Sweet black birch bark will do, if you do not know of any convenient patch of wintergreens. Or the foundation of the beer may be a peck of birch bark, with one of wintergreen leaves. Whatever is used, add to it a peck of young spruce twigs and half a peck of prince's pine gathered before it flowers, and a handful of sweet cicely or fermet leaves. Cover these twigs, bark and leaves with boiling water and let it boil down until their strength is extracted. It will take about twenty minutes' boiling. Strain the liquid off the herbs and bark, and to every gallon add a pound of sugar and half a cake of compressed yeast. Do not add the yeast until the liquid is lukewarm. Some old-fashioned people prefer to use a portion of honey to sweeten their root or ginger beers. A pound to two gallons is a good proportion. In such a case half the quantity of sugar should be used. Mix the beer with the yeast in a large cask, and when it has stood for two or three days it should be ready to bottle. Stir it two or three times while it is rising. When it is foaming bottle it. Use some of the various bottles with patent corks, which are in no danger of expanding prematurely and causing destruction around them, as the old bottles tied down with a cork often did. Set the bottles in a cold cellar. The beer will keep several weeks, but is fit for use as soon as it is bottled.

Hektograph Mass.—The following is a formula recommended by Peltz, in Phar. Zeit. fur Russ.: Steep overnight one part of gelatine in 9 parts of water, and in the morning add to it ⅙ part of glue and the same of gum arabic dissolved in ⅙ part of water, and 1 part of granulated sugar. Heat the mixture to boiling, add 4 parts of glycerine, and boil the whole for a quarter of an hour; then skim and pour into a suitable tray.

ENGINEERING NOTES.

Secretary of the Navy Herbert has decided that it is against public policy to permit representatives of the press to witness tests of the armor made for the navy at the Indian Head Proving Ground. Hitherto the results of the tests of armor for American war vessels have been freely published, but foreign governments have kept strictly secret their own experiments in this regard, and the secretary thinks this is a sufficient reason why the practice in this country should be changed.

Hollow brick, it is said, are coming into more general use in Eastern cities, and quite a number of large buildings have been built with them. They crush at 30,000 lb., or about the pressure which the best solid brick will stand. They are made 8 × 8 × 12, with walls 1 in. thick. It is claimed that they cost one-third less than the regular form, making walls proof against fire, moisture, and frost, being warm in winter and cool in summer. They require a peculiar clay in their manufacture, one that will not shrink when dried or burned. The brick are set on end, thus making a wall hollow from top to bottom.

The Port Orchard dry dock, built for the United States navy, at Seattle, Wash., was formally opened on April 23 by the entrance of the monitor Monterey. The dock is of timber construction. The contract for the work was awarded in October, 1892, to Byron, Barlow & Company. The general dimensions are as follows: Length over all, 749 ft. 8 in.; length over coping, 650 ft. 5 in.; length on floor, 573 ft. 7 in.; width over coping, at middle, 130 ft. 1 in.; width on floor, 67 ft. 1 in.; width of entrance, 92 ft. 8 in.; height from floor to coping, 39 ft. 3 in.; height from sill to highwater line, 30 ft.; height from keel blocks to highwater line, 28 ft. 2 in.

In an article in Le Génie Civil M. Guillemoux concludes that aluminum is a suitable material for seagoing vessels, and that the failures made in the past have been due solely to lack of knowledge of the nature and proper use of the metal. He insists that the metal selected for shipbuilding purposes should be as free from impurities as possible. It should be tested by the galvanometer, and only ingots surpassing in electro-positiveness a standard well tested by experiment in sea water should be accepted. The ingots should also be fused together as completely as possible, so as to secure homogeneity. Subsequently care should be taken to avoid contact with copper in any form, and also to paint all the surfaces exposed.

Mr. W. J. Humphreys has examined quantitatively the solution and diffusion of tin, lead, bismuth, zinc, copper, and silver in mercury with a view to determining the extent to which these phenomena differ, if at all, from the solution and diffusion of non-metallic solids in liquids. Pieces of metal were placed on the upper surface of a column of pure mercury, and samples of the liquid were taken at definite depths below the surface and the amount of foreign metal estimated. As far as the experiments go the author concludes that the solution and diffusion of metals in mercury do not essentially differ from those of non-metallic solids in liquids. Copper and silver dissolve in mercury to a very small extent at ordinary temperatures, but diffuse very rapidly.

On May 17 a converter in the American Glucose Company's works, at Peoria, Ill., exploded with terrible effect, two men being instantly killed and several others being dangerously injured. The converter, which was of copper, 5 ft. in diameter and 14 ft. long, was used to convert liquid starch into glucose, steam being used in the process. When the accident occurred, it is said that there was no way of shutting off the steam outside of the room in which the explosion occurred, and the converter room could not be entered to remove the injured until the fire had been drawn from the boilers, and the latter cooled down. The Peoria Journal stated that the copper shell of the converter was ⅜ in. in thickness originally, but it was worn down to ⅛ in. by the corrosive action of the acids.

Experiments made with ropes and belts by M. Fauquier and published in the proceedings of the Société des Ingenieurs Civils, show that with a smooth rimmed pulley running on carefully prepared bearings, he determined the weight required to maintain a constant speed of rotation, when attached alternately to loaded belts and loaded ropes passing around the rim; the added effect of the grooves of a rope pulley was ascertained by measuring the moment of resistance due to the sticking of the rope in the groove. Pulleys of three different diameters were tried. From the results he derives a formula by which the loss of power due to the stiffness of ropes and belts may be calculated, the conclusion being that rope gearing absorbs from one and one-half to three times the total power that is lost in belt gearing.

In welding large and small pieces together, especially of different metals, it is not necessary to heat both pieces to the same degree of temperature, says the Engineering Review. In case of putting a small piece of steel upon a large piece of iron, as happens when a steel bearing is to be put on an end of an iron shafting, the latter can be heated to the ordinary welding heat, while the steel need only be heated bright yellow. This is taken advantage of many times in order to weld together cast steel and wrought iron, especially in the case of cutting tools, where it is necessary that the steel shall not lose any degree of fineness through being overheated. In the case above mentioned of facing the end of a shaft with steel, separate fires can be used for heating the two pieces—a large fire for heating the end of the shaft, and, after it is nearly hot, the steel can be heated in a small fire. When nearly to a yellow heat it may be transferred to the larger fire and placed in position upon the end of the shaft without removing the latter from the fire. A few blows from a large sledge hammer, or from a ram suspended from some point overhead, will unite the two pieces of metal, after which they may be removed from the fire and finished up in usual manner by hammering or swaging down to the original diameter of the shaft. In uniting steel to the end of the shaft, the latter is upset necessarily to a certain degree, and the increase in diameter must be reduced by swaging, as above noted.

ELECTRICAL NOTES.

The telephone and the telegraph are rapidly making inroads into the arid portions of the Desert of Sahara. Engineer Bayolle is now on the way from Biskra to Tuggurth with a working force of one hundred men, for the purpose of laying telegraph wires between the two places.

Electric lines in Europe increased in number from 70 to 111 during 1895, their length from 700 to 902 kilometers (560 miles), and the power from 18.150 to 25,095 kilowatts. Germany leads with 406 kilometers, followed by France with 132 and England with 107, and Switzerland fourth with 47. The only countries still free from electric traction are Bulgaria, Greece and Denmark.

In view of the recent experiments with storage battery traction tried in New York City, New Ideas says it is of interest to note that there are eight storage battery roads in Europe, four of which were installed during the past year. The largest system of this type comprises three roads in Paris, operating nineteen storage battery cars, some of which have been doing duty since 1892, and the addition of a fourth road last May seems to indicate that, for the conditions there existing, the storage battery has proved satisfactory. The other four roads are located—one at Birmingham, England, one at Hague-Scheveningen, Holland, and two in Austria-Hungary.

A company has been organized for the purpose of constructing an electric rack railway from Zermatt up the Gornergrat, Switzerland. This eminence is about 10,500 feet high and is a well-known point for obtaining a fine view of the surrounding Alps. According to the London Electrician, the railway will be six miles long and will have an average gradient of 15 per cent. and maximum gradient of 20 per cent. Each train is to consist of two cars and to carry 100 passengers. The time of complete journey will be two hours. Power is to be obtained from the Findelen River. The total cost of the line is estimated to be about $700,000 and it is expected will be opened in 1898.

Dr. Peterson and Mr. Kennelly recently conducted experiments at the Edison laboratory to determine what, if any, effect was produced in the human organism by subjection to a magnetic field of great power. The results of their work are given in the New York Medical Journal; they reached the conclusion "that the human organism is in no way appreciably affected by the most powerful magnet known to modern science, either as regards circulation, ciliary or protoplasmic movements, or sensory or motor nerves." The writers also express the opinion that "the ordinary magnets used in medicine have a purely suggestive effect, and would be equally serviceable if made of wood."

Before a recent meeting of the Institution of Electrical Engineers, says the Engineering and Mining Journal, Mr. R. Appleyard read a note on the action of sulphur vapor on copper. When a copper wire is exposed for some time to the action of sulphur vapor it becomes entirely converted into sulphide of copper, and it is found that there is a fine axial hole running down the rod of sulphide formed. Rods of copper of square section cut from a block of copper, after exposure to the action of sulphur vapor, also exhibited the axial hole, the rod of sulphide formed being of circular cross section. In every case the diameter of the rod of sulphide formed is about twice that of the original rod of copper. Delta metal was found not to be acted upon by the sulphur vapor.

The Engineering and Mining Journal says: The rise in copper is caused by consumers and the public finding consumption exceeding production. While supplies are offered freely, speculators absorb them readily. There is more demand for refined copper for India and elsewhere. A contract has been placed for French Pacific cable which requires 900 tons of copper wire. American electrolytic copper has been repurchased, owing to reduced output of American mines. A financial paper asserts that the recent investments of the Rothschilds in Anaconda mining stock, where hitherto they had been content to buy the products, is a significant "pointer" of the growing value of copper ledges and of a coming boom in good copper stocks.

A water power of about 3,000 horse power, situated about eleven miles from Hartford, Conn., will be used to drive multiphase alternators, the power to be transformed at the falls to 10,000 volts and transmitted on a pole line to the Hartford Electric Light Company's station in Hartford, where it will operate motors driving shafting to which will be belted arc lighting machines, and from which point alternating current will be distributed for incandescent lighting. From the station mentioned the current will be carried to the storage battery station at a pressure of 2,000 volts, where it will be transformed to 240 volts and put through a rotary transformer for charging the battery, which will be operated on the three-wire system. The battery will consist of one hundred and forty 10,000 ampere hours chloride accumulators.

At a recent meeting of the Physical Society, Mr. R. Appleyard read a paper on "Dielectrics." The author has particularly investigated the effect of temperature on the dielectric resistance. He has employed for this purpose condensers insulated with mica and paraffined paper. In order to eliminate some of the effects of surface leakage, Price's guard ring arrangement was made use of in all the experiments. The author finds that the capacity of a paraffin condenser varies irregularly with the temperature, but that to within the accuracy attainable with his instruments—1 per cent.—the capacity of a mica condenser is constant between 33 deg. Fah. and 110 deg. Fah. If the resistance of paraffin at a temperature t is represented by $R_t = R\,a^t$ the mean value for log. a deduced from all the author's measurements is T 0·96344. Experiments made with a parallel plate condenser, with paraffin as the dielectric, show that when the temperature reaches within about 20 deg. of the melting point the resistance rapidly falls; when melting commences there is a rapid drop, but while melting is in progress the resistance remains constant.

MISCELLANEOUS NOTES.

A visitor was dining with a French women, who certainly has a reputation for economy. A cherry pie had been on the table, and the mistress ordered that all stones were to be scraped from the plates and placed in her store room. Venturing to ask the reason, the visitor was told that not only cherry, but plum, peach and all stones, whether cooked or raw, were invariably saved, gently dried in the oven, and kept in a great jar. "Then," says madam, "in the winter, when the fire burns clear and bright in the evening, I fetch a handful and throw them among the glowing coals. They crack and sputter a moment, send up a brilliant flame, and the whole room is filled with a delicious odor."

There have been many materials employed, and still more suggested, for the manufacture of cocks suitable for use in chemical works and those industries in which acid and corrosive fluids have to be controlled. The field for a cock applicable to the brewing, vinegar, and similar trades has up to the present been practically a virgin one, and in view of this Messrs. Bennett, Sons & Shears, of London, have recently made an aluminum and ebonite cock upon the lines set forth in Deville's patent. The barrel is made of aluminum, and is fitted with a vulcanized plug, and the wear and tear are said to be very small. The use of aluminum presents a great advantage over numerous well-known alloys, as it is not of so poisonous a nature as lead.

Perhaps the most interesting question to be solved by the discovery of the north pole is the question whether or not any human beings are to be found in its vicinity. It is not wholly improbable. The town of Werkojausk, in Siberia, is situated in north latitude 68°. Whether or not human life will be found at the pole, it is certain that the unexplored pole region is inhabited by various animals. The rosy gull, two species of sandpiper, as well as at least one variety of ducks, are known to breed there. There is reason to believe that fish abound in the open Polar Sea, and the probability of a flora as extensive as that of Spitzbergen, mosses and lichens, with perhaps a few flowering plants, such as the yellow Arctic poppy.

One of the most important vegetable productions of Persia is the crop of dates, which are grown to great perfection in many parts of the country, says the Garden and Forest. The date palms begin to yield at about three years of age, reaching their prime at thirty, and a good yield for one tree is from eighty to one hundred pounds. The flowers are fertilized by hand, one male tree supplying pollen for perhaps forty pistillate trees. The dates used for export are those that grow at the summit of the trees. From the action of the sun they become hard and dry and are thus easily packed, while those on the lower branches remain soft and are kept for local consumption. The exports of dates of the country could be easily doubled by planting fresh groves of palm.

The dwarf palm, so abundant in Africa, has been profitably used by French artisans, the leaves furnishing 50 per cent. of a fiber which is extensively used as a cheap substitute for horse hair. The fiber is extracted either by hand combing or by means of drums, with needles and knives worked by steam power. The green fiber is twisted or curled in its raw state, and finds several applications. The black sort is at first dyed in baths of sulphate of iron and logwood, then twisted and again dyed. This fiber possesses two advantages over animal fiber: it is exempt from insect destruction, and some 75 per cent less expensive than horse hair. In Algeria there are several large factories which produce tons of the material every month for commercial purposes.—Boston Journal of Commerce.

A representative of the Cleveland Twist Drill Company, in China and Japan, describes the manner in which their tools were brought before a large concern in one of the leading cities of China, says the Railway Review. It seems that he had hired an interpreter and had one of his twist drills with him ready to show, when, after waiting some time, the intrepreter failed to put in an appearance. So Mr. Prentiss decided to go alone. After reaching his destination, an immense arsenal, he sent up his business card to the manager. Failing to get a cordial response from that, he next sent up a twist drill. That elicited curiosity from the firm, and he was straightway invited up to explain the curious tool. After making various signs that he wanted a piece of steel, he was brought some iron. That he tossed aside, and hunting around, found a piece of the harder metal for himself. Then Mr. Prentiss proceeded to bore hole after hole in it with his twist drill, to the amazement and delight of the workmen, whose primitive way of pounding holes in iron is most unsatisfactory. It is needless to add that Mr. Prentiss got a big order before he left that city.

According to the statement made by Mr. H. Schweitzer, of New York, says the Engineer, some of the refiners of American petroleum have a new way of adulterating their products. This consists in making up oil from a mixture of "top and bottoms," i. e., naphtha and the last boiling, or heavy oil. It is stated that these mixtures can be made to show the same flash point and specific gravity as the best burning oils; and as the boiling point is also the same, only an exact fractional distillation would furnish means for detecting the adulteration. For this purpose, Mr. Schweitzer advises the use of the solidifying test generally, which also shows the amount of solid paraffins present in the oil. Upon this the American Manufacturer says: Herr R. Kissling remarks that he has used the solidifying test daily for at least twenty years, not because of its supposed value as a test of the burning and illuminating power of the oil, but because the separating out of the paraffins in cold weather might give rise to great inconvenience. For applying the test, Mr. Kissling makes use of an appliance consisting of a couple of concentric tin cylinders, containing a mixture of ice and salt. Into this, standing upon a cork plug, is inserted the oil in a glass tube which also contains a thermometer. According to Mr. Schweitzer, one of the large American railway companies demands that oil flashing at 150° to 175° shall remain clear when cooled and kept for ten minutes at 1° Fah.; and 300° oil must remain clear when cooled to 32° Fah.

THE DIRECT MANUFACTURE OF BUTTER FROM MILK.

IT may seem strange at the outset that we should speak of the manufacture of butter from milk as a novelty; so let us say at once that it is a question here of the direct and immediate production of the article. Although milk is always used for making good butter in the processes usually employed, it requires a certain length of time for the skimming, the acidification of the cream and the churning. With the centrifugal that we saw in operation at the last Agricultural Exposition of Paris, it suffices to pour the milk into the apparatus in order to obtain butter a minute afterward.

This new apparatus, which was devised by Mr.

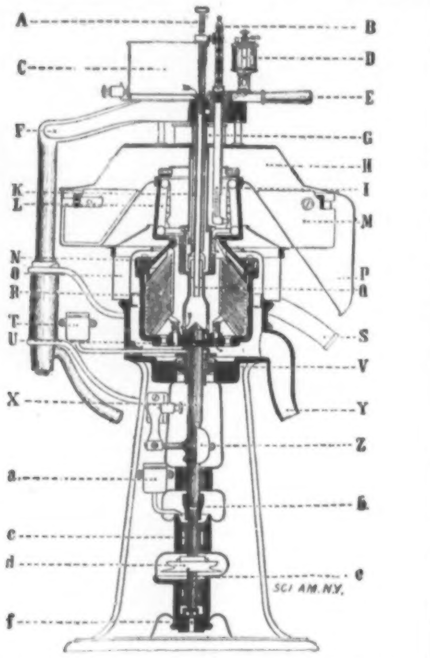


FIG. 1.—SECTION OF THE CENTRIFUGAL.

Salenius, a Swede, has been in use for the last two years in the country of its origin.

It consists in principle of two superposed vessels which have a rotary motion that reaches 6,000 revolutions a minute. The conversion of the milk into cream is effected in the lower vessel, and that of cream into butter in the upper one. But, although in principle such manufacture is simple, it really presents a little more complication than the above remarks would seem to indicate. Fig. 2 shows the details of a complete installation. It comprises, in addition to the radiator, a water reservoir and a pasteurizer. The milk is put into the vat and is thence sent by a pump to the pasteurizer, where it is raised to a temperature of 70 degrees. It then passes to the centrifugal, which it enters at d (Fig. 1), and descends to the bottom of the skimming vessel, N, through the tube, V, the lower part of which is applied to the bottom of the vessel and allows the milk to escape through four lateral apertures. Around the walls of the skimming vessel there are superposed twenty-five partitions, S, upon which constantly flows cold water that afterward cools in the same manner the walls, B, of the churning vessel, R, and then escapes through a lateral tube. The churning vessel is fixed upon the skimmer in such a way as to allow the cream to pass through the bottom, while the skimmed milk escapes from the apparatus and flows into a receptacle in which it may be preserved; but in the installation represented in the figure it is sucked therefrom by a pump and sent to a refrigeratory, U. The cream entering the churner is distributed in a thin layer over the surface of the cold walls of the latter and is rapidly brought to the normal temperature. The churning is effected by means of a tube whose sharp edged aperture, turned in a direction opposite that of the rotation, is brought into contact with the layer of cream by means of the handle, a. The cream enters the tube with force and is submitted therein to multiple shocks that bring about the agglomeration of the butyraceous globules in suspension, and then escapes through 120 small apertures in the wall of the tube, and is violently projected in fine streams upon the layer that covers the wall of the vessel and in a direction opposite that of the rotation. The butter is then produced in the form of grains, which collect in the center and rise to two apertures, whence they fall into the upper jacket, where two slowly revolving arms assemble them and carry them to the part, G, where the butter is collected.

In case it is desired to use the apparatus as a skimmer solely, the handle is not maneuvered and the cream is collected before it has undergone a churning.

There are two models of the apparatus—one permitting of treating 200 gallons an hour and the other 44 gallons.

From the experiments to which the centrifugal has been submitted at the practical dairy school of Poligny by Profs. Friant and Houdet it appears that the apparatus operates with great regularity. Despite the great velocity with which it revolves, and the absence of any foundation, it produces neither noise nor vibration. The mounting is simple and capable of being effected by the personnel of any dairy.—Revue Universelle.

THE PRESERVATION OF WOOD PULP.

THE association of German manufacturers of wood pulp has offered a prize of 3,000 marks (3,750 francs) for the discovery of an efficacious means of preserving wood pulp in a damp state. It has been known perfectly well for a long time that manufacturers could preserve the pulp for only a short period, although in the moist condition it permits paper makers to use it without difficulty and without previous preparation.

Of course, if the pulp is preserved in a desiccated condition, in the form of coarse pasteboard, which does not add materially to its original cost, it can be kept for some time without any material or deleterious change. But before it can be used in the manufacture of paper it must be macerated or ground up, which adds greatly to the expense, and besides, many paper mills have not enough of the necessary macerating machinery.

Many European paper makers experienced this trouble in a marked degree during the winter of 1893–94, from the general decrease of the water supply, owing to a general drought, their mills being run by water power, and they were obliged to use an old stock of pulp, which could only be procured in a dry state.

At the present time two processes of preservation are under trial, which are recommended by Mr. Chr. Braun, of Rochsburg, Saxony. One method consists of running the wet pulp from the machine on to an endless sheet of thin linen, 1·5 to 3 mm. thick, and which is not submitted to any pressure. This leaf or sheet of pulp is extremely spongy, and is either dried in the sun or artificially.

The pulp thus prepared, contrary to the ordinary pasteboard pulp, which is pressed to extract the moisture, is thinned very easily in the desiccators, and keeps in good condition for some years.

Nevertheless this process implies the expense and delay of drying the pulp, and this fact has induced Mr. Braun to try the following method, at a much less expense: He dug long trenches in the earth, which he lined and covered with boards, to prevent the paste from getting dirty. Down these trenches he runs the wet pulp, and the water separates by gravity, by absorption and by evaporation, leaving the pulp in a condition still moist enough for use without redesiccation. It is claimed by Mr. Braun that pulp prepared by this process gives very satisfactory results nearly five years after it is manufactured. This process, notwithstanding, still leaves a want unsupplied, under certain conditions, and this is why the German society has offered a reward of 3,000 marks for an entirely satisfactory process of preservation.—Translated especially for Hardwood from the Moniteur Industriel.

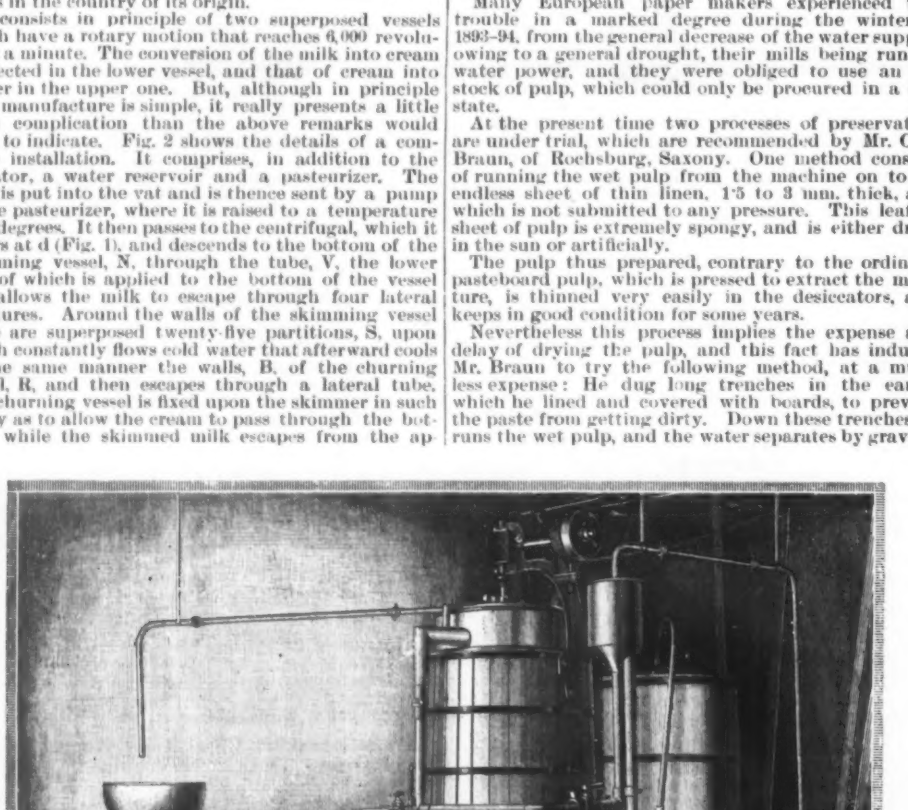


FIG. 2.—COMPLETE INSTALLATION OF A CENTRIFUGAL.

PLATE SPEEDS—THE HURTER AND DRIFFIELD METHOD, AND THE ACTINOGRAPH.

By THOMAS BOLAS, F.C.S., F.I.C.

THERE is no difficulty in comparing with sufficient accuracy the relative sensitiveness to light of materials which, like ordinary albumenized paper, darken on exposure to light; the degree of darkening being a direct (although not strictly exact) measure of sensitiveness.

Nothing even approximately similar holds good in the case of an ordinary gelatino-bromide plate, which only darkens on the application of the developer; as any required amount of opacity may be obtained by the action of a developer only, or à fortiori by a developer in sequence with an exposure to light. Let it now be supposed that we so limit the nature and action of the developer that all unexposed parts of the plate remain clear, while the exposed part acquires a given richness in metallic silver or density. This excludes such blackening as can be produced by the action of the developer alone, but even when the condition of clear glass alongside of the developed patch is imposed, the exposure required to produce a definite degree of opacity affords only a very imperfect and partial measure of sensitiveness. If, however, we know in addition what is the minimum of exposure which will yield a visible impression (or more strictly the first step in reduction) on similar development, we have information of somewhat greater value; but merely gaging the minimum of light required to yield a visible impression on development will by itself give no useful information as to the sensitiveness of a plate, as the following consideration will show. Let two units of exposure be necessary to overcome what may be called the inertia of the plate and give the faintest perceptible image on an untinted ground. If now the plate has a general exposure of one unit and a local exposure of one unit, it may be so developed that those parts only will tint which have received the local exposure. Gaged by this method alone, the plate would seem to have had its sensitiveness increased by a pre-exposure, whereas there has been no increase of sensitiveness in any real and useful sense, although as regards the minimum light action which it can register, it may be considered that there is an increase.

The real or useful sensitiveness of a plate cannot then be determined by a single observation made at either extreme of its range of tone representation, as might be the case if the aim of ordinary photography were to make a negative with only one difference of transparency; in fact, the kind of negative which the photolithographer aims at producing.

Messrs. Hurter and Driffield, fully realizing that any numerical expressions of sensitiveness must set forth the relative rapidity with which plates will register such a scale of gradations as is met in nature, undertook and carried out a remarkable series of researches, the central principles of which I shall endeavor to explain; this explanation being introductory to some account of the practical outcome as it affects those using rather than preparing plates.

The density of any part of the negative film is, according to the definition of Messrs. Hurter and Driffield, directly proportionate to the amount of silver in the film; and their unit of density is that which will cut off one-half of the light and transmit one-half. Therefore, for a density of 1 the transparency will be ½, and the opacity, which is reciprocal to transparency, will be 2. Let us now suppose the density is 2 units. The first half of the film (1 unit) will reduce the light to one-half, and the second half will reduce that half of the light which escapes once more to half; so each addition of a unit of density will halve the light or double the opacity, and if tabulated, the method will stand thus:

Units of Density.	Degrees of Transparency.	Degrees of Opacity.
0	1	1
1	½	2
2	¼	4
3	⅛	8
4	1/16	16
5	1/32	32
6	1/64	64
7	1/128	128
8	1/256	256

The numbers in the first column representing increases in density (relative weights of metallic silver in the film) form an arithmetical series; that is, there is a constant difference (1 in the present case) between adjacent terms of the series; while the numbers in the second column, like those in the third column, form a geometrical series, where we always have a constant ratio or proportion between adjacent terms.

It is very important to understand at this stage that the graduation of any arithmetical series is essentially un-uniform; in fact, no two steps in the progression are strictly comparable; while every step in a geometrical progression is similar to any other step.

Our arithmetical series starts with a zero, and from this to the first term cannot be measured by a proportion; it is infinity if regarded as a ratio—it is from nothing to something. The ratio is changed between each two successive terms, and as we get higher in the series the adjacent terms approximate more and more nearly to equality between themselves—they are always becoming nearer and nearer to equality, but can never become equal.

Let us imagine that sticks are cut to lengths, in feet, corresponding to the figures in the first column. The stick 0 feet long (or the non-existent stick), when set up by the side of the 1 foot stick, will convey no idea of

proportion or graduation, but when the 1 foot stick is set up by the side of the 2 foot stick a certain sense of proportion is given which disappears when the 2 foot stick is set up alongside of the 3 foot stick. If we go on until we come to the million foot stick, and we view it with a telescope by the side of the million and one foot stick, the two will appear substantially equal. In other words, the terms of any arithmetical series become ultimately equal according to the spirit of that Newtonian doctrine of ultimate equality which has revolutionized modern mathematical research. If we now cut sticks to lengths indicated in our geometric series, any two sequent sticks will produce precisely the same effect on the beholder; one will be half the length of the other.

The graduations of the equally tempered diatonic scale appear to us uniform, because this scale is in geometric progression, any two adjacent notes having the same relation to each other, and numerous instances of the essential uniformity of geometric progression and the essential un-uniformity of arithmetric progression might very easily be drawn from affairs of everyday life; but to illustrate this fundamental matter to the eye Messrs. Hurter and Driffield partially clothe two black cylinders with white paper, so that the arcs covered with white at each successive unit of length of the cylinder shall correspond to an arithmetical series and a geometrical series respectively. The former cylinder on rotation gives the impression of an abrupt transition of tone, while the latter conveys the impression of uniform gradation. To show experimentally that a film in which the amount of silver increases according to arithmetical progression will transmit light in geometric ratio, they constructed an artificial negative in the form of a wedge of jelly containing finely divided silver.

As a consequence of what is stated above, it will be obvious that a negative cannot truly reproduce, in terms of opacity, the gradations of light and shade of the original, unless the relation of the reduced silver in the film to the light acting on the plate corresponds to the relation of the units of density (col. 1) to the degrees of opacity (col. 3). That is to say, exposures to light which increase in geometrical proportion must bring about such reduction of silver that the amounts are represented by figures in arithmetical progression. The most interesting and laborious part of Messrs. Hurter and Driffield's researches is their quantitative investigations as to the silver liberated in the film (density), as a consequence of definite series of exposures.

They find that when a series of graduated exposures is commenced, the density of the resulting deposit of silver at first increases very nearly in proportion to the action of the light, but as the exposure is prolonged, the density of the resulting deposit of silver becomes less, relatively to the exposure, and through a certain range determinable by experiment it will be found that equal additions to the reduced silver result from each successive doubling of the exposure, but after a time the silver increases less rapidly with the increased exposure, and finally the deposit becomes less for an increased exposure to light, this being the period of *reversal*. Plates of different makes vary much as regards their behavior in the above respect, and the range through which the reduced silver corresponds to equal additions for each doubling of the acting light varies much; but as this range corresponds to the effective sensitiveness of the plate, the sooner it is reached, so much the more sensitive is the plate, and the longer this range, so much the more completely will the plate register a wide scope of gradations in tone. For the purpose of the present article it is not necessary to describe the methods adopted by Messrs. Hurter and Driffield for determining the relation of various exposures to density, but in ordinary practice they give a series of exposures increasing in geometrical progression and plot out the results for each particular plate, thus obtaining what they call the "characteristic curve" of the plate. That portion of this curve which corresponds to a straight line represents the silver deposit in arithmetical proportion. This corresponds to what our authors call the range of correct exposure, and its production to a scale gives a speed number which indicates the minimum exposure which will give a true gradation; but in many cases the period of correct exposure is so extended that a twofold exposure may be given without harm. Development may be so varied as to give a dense negative or a thin negative, and the scale of gradations may be compressed or extended, while irregular development may be brought about by the use of developers capable of reducing unexposed silver bromide; but Messrs. Hurter and Driffield strenuously maintain that the ratio of the densities to each other cannot be affected by changes in the mode of development, and they assert that the reproduction of true gradation depends essentially on the exposure, and this position they have supported by numerous quantitative experiments.

Few researches are so closely surrounded with difficulties and disturbing agencies as those undertaken by Hurter and Driffield. Take, for instance, the complex nature of light and the fact that radiations which do not affect the human eye will bring about the deposition of silver in the film. But an enormous amount of labor—more, in fact, than could be expected of two men in a lifetime—would be required to fully take account of all disturbing influences.

The practical outcome of all this is that, by making a series of test exposures on a plate, developing, measuring the density of the silver deposits with a specially constructed photometer, plotting the characteristic curve, and determining the relation of this to a scale on the plotting out ground, Messrs. Hurter and Driffield can obtain a speed number which represents the working speed of the plate for just gradation, and takes no account of those fainter impressions which are out of true gradation; and similarly it takes no account of any previous fog impression on the plate. An exposure being given according to this speed number, development becomes easy and certain.

The small calculating machine devised by Messrs. Hurter and Driffield and sold as the "actinograph," by Messrs. Marion & Co., although constructed with special reference to plates marked with numbers on the Hurter and Driffield system, becomes available for other plates if by a reversed use of it an approximate number on the Hurter and Driffield system is obtained.

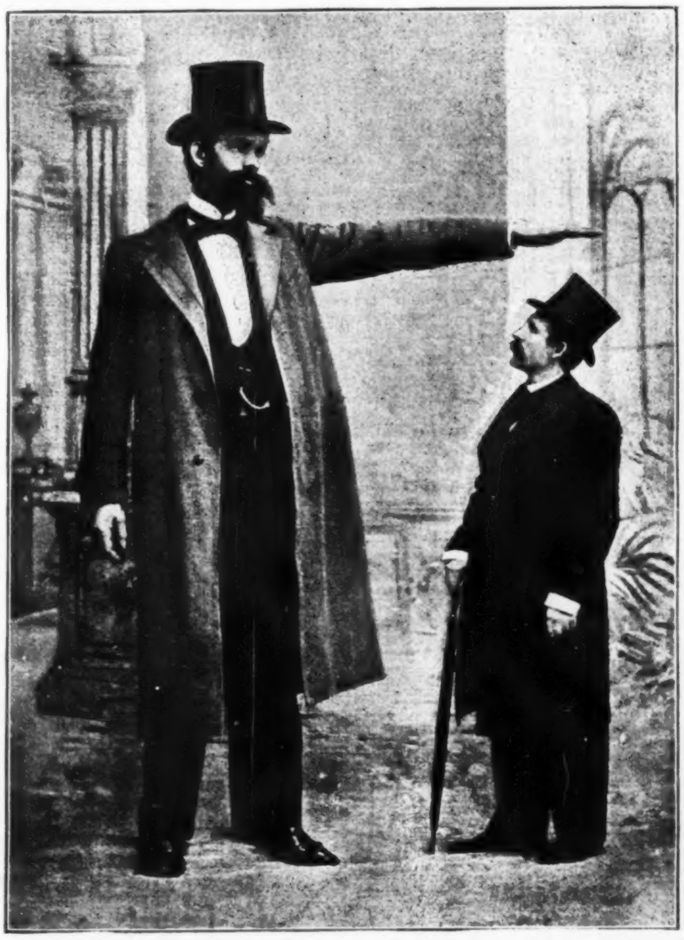
This actinograph (an instrument not to be confounded with Herschel's actinograph) is supplied in a light mahogany box, 4½ in. by 2¾ by 1¼, and it weighs altogether 4 oz. Inside at the back is a cylinder, upon which is a chart showing graphically the intensity of daylight for every hour of each day of the year; daylight being constant for a given season and locality, apart from atmospheric influences and eclipses. The slide next to this cylinder is furnished with two scales; one marked for lens apertures and the other set out for exposures. Next to this is a small pointer slide which is adjusted to a fixed plate speed scale; and the pointer slide now indicates the exposure for each of six selected and typical meteorological conditions.

Although the actinograph is complex it is very compact, and everything can be adjusted and an indication of the necessary exposure obtained in five seconds. A person who uses it for exposing his first plate may feel sure of not going considerably wrong, provided he uses plates marked according to the Hurter and Driffield system; and pending the introduction of a better system, I think plate makers would do well to mark all packages with the Hurter and Driffield speed number. At present the Marion plates and the Cadett plates are so marked.

The actinograph as sold for use in this country is plotted out for a latitude of 50° 30', but instruments are supplied for any desired latitude. I would, however, suggest that for the convenience of tourists a set of curves for various latitudes should be printed and issued with each instrument, so that any one of these could be placed temporarily in position as required, either between the cylinder and the first scale or otherwise. As I assume the curves for tropical latitudes would come outside the limits of the cylinder, perhaps outside the limits of the case, some system of register marks or multiplying factors would probably be required.—The Amateur Photographer.

HORTICULTURAL SCHOOLS IN BELGIUM.

THE Belgian government has, for a long time, contributed generously to the support of agricultural and horticultural science, which has become a national study. There are two government schools of agriculture—one at Glembloux, the other at Hay. The United States consul at Ghent says that two schools of horticulture likewise are under state management; one of them is at Ghent and the other at Vilvorde. In addition to these establishments there are twenty-four agricultural schools under private management, but subsidized by the national government. They receive annual donations upon the condition of teaching the course of studies prescribed by the state, and granting diplomas only after an examination under supervision of the authorities. The schools are situated at La Louviere, Leuze, Dinant, Virton, Carlsbourg, Grammont, Avelghem, Deynze, Sottegbem, Waremme Hasselt, Eecloo, Thielt, Ellezelles, Tessenderloo, Ninove, Beauraing, Zelzacte, Alost Gyseghem, Lennick, St. Quentin, Termonde, Iseghem, and Vise. Instruction in agriculture is also given to girls and young women of the peasant classes at the female institutes situated at La Hulpe, Gyseghem, Virton, Isque, Heule, Herve, and Brugelette. Instruction is also given in the principles of agriculture in all the more important garrisons, so that after his period of service the peasant youth may return home with a knowledge sufficient to enable him to intelligently till the fields. The school of horticulture at Ghent was founded in 1849. The teaching staff consists of a director and six professors. The course of instruction is entirely free to Belgians, but foreigners must pay a fee of about £7 per annum. The school is required by the state to combine theoretical and practical work; the tone of its instruction is highly scientific. It aims to graduate learned horticulturists, and is particularly devoted to the cultivation of ornamental flowers and plants. The institution at Vilvorde, on the contrary, pays especial attention to the kitchen garden, and endeavors to educate practical workmen. The Ghent school makes a specialty of the cultivation of hybrids and of work in the laboratory. The chief plants cultivated and studied are palms, ferns, azaleas, and camellias. Aboriculture is taught to perfection. The course of instruction covers a period of three years. The examinations for admission take place during the first week in October, and the candidates must be 16 years of age. The subjects of examination are an exercise in writing and orthography, a simple composition, arithmetic (including the metric system), explanation of a printed extract, general geography, and national history. All the lectures at the school are given in the morning, and during the afternoon the students are divided into three sections. Each of these sections is occupied one week at a time in a horticultural establishment, in a nursery, and in the botanical garden, rotating throughout the year between these three places. A thoroughly practical instruction is thus imparted. Examinations for advancement from one class to another are held every August before a jury appointed by the government. In addition to the regular course of instruction there are several annual series of lectures which are open to the public. For example, for thirty-five years there have been given annually twelve to fifteen lectures on fruit tree arboriculture. These are delivered on Sundays in



MR. WILKINS, THE LARGEST MAN IN THE WORLD.

THE LARGEST MAN IN THE WORLD.

MR. WILKINS, an American who recently exhibited himself in the Orpheum, the most fashionable variety theater on the Wasagasse, in Vienna, has been pronounced by the anatomists of the Vienna University, with Dr. Zuckerkandl at their head, the largest man of whose size there was a scientific record. Especial weight is given to this declaration of the Vienna professors because the Vienna Anatomical Museum possesses the largest human skeletons, and the founder of this institution, the late Hofrath Langer, and his successor, Dr. Zuckerkandl, are considered the highest authorities on the subject of giants. They pronounced Mr. Wilkins remarkable, not only on account of his great size, but also because his development is entirely normal, while, as a rule, giants are not well proportioned and they often suffer from some weakness. In parting the professors told him that if he would examine the skeletons of the museum he would soon be convinced of his own superiority. The horrors of the grave need never worry him, for, unless he makes special provision against it, his skeleton is most certainly destined to ornament some anatomical museum. He is 8 feet tall, and our engraving (for which we are indebted to the Illustrirte Zeitung) gives a very good idea of his height, for here he is shown standing beside his impresario, a man 5 feet 10 inches tall.

Flemish, especially for gardeners, and every Thursday they are repeated in French for the general public. For three years a course of lectures upon kitchen gardening has also been given. As regards the commercial relations of horticulture which have in recent years contributed so greatly to the prosperity of Ghent, the number of horticultural establishments in Ghent and its suburbs is 366. There are 2,535 hothouses, with 3 625,500 square feet of glass roofing. The total space occupied by cultivation amounts to 1,521 acres. There are about 20 very large establishments, and these have 70 to 72 hothouses each. Concerning the capital invested accurate statistics do not exist, but estimates vary from £800,000 to £3,000,000. The difference may be explained by a variation in the extent of territory comprised in these respective figures. Numerous societies exist throughout Belgium for the promotion of the interests of horticulture, the most important organization of this kind being at Ghent—the Royal Society of Agriculture and Botany. There are altogether in Belgium 25 important, and 15 smaller societies of horticulture and botany. The total membership approximates 12,000. There are a dozen great floral exhibitions annually held in Belgium, and prizes amounting to £1,000 are yearly distributed. Finally, all these various societies are united in a national organization known as the "Federation des Sociétés d'Horticulture de Belgique." This organization holds annual conventions, and publishes a series of bulletins in the nature of reports of its proceedings. The first international congress of horticultural botany was held at the Brussels Exposition of 1864. In 1868 the meeting place was Ghent. These congresses are held regularly.—Journal of the Society of Arts.

THE MEKONG MISSION.

If it be desired to compare the Indo-Chinese peninsula to a living organism, it must be said that the Mekong is the great artery of it. Proceeding from Thibet, where Prince Henri d'Orleans has recently unveiled the mystery of its sources, the river, after irrigating Yunnan, exhibits a series of capricious meanders that separate Tonkin from Burma and Annam from Siam, then becomes Cambodian and Cochin Chinese, and empties into the Chinese Sea through numerous branches that make the southern part of the peninsula one of the richest deltas of Asia.

From the point where it waters French soil as far as to the sea, the course of the Mekong measures no less than 1,500 miles.

The object of the Mekong hydrographic mission, the command of which was intrusted three years ago to Lieut. Simon, of the navy, was to make a definitive map of these 1,500 miles of river, to take gunboats as high as possible into the upper reaches, and to thus take effective and indisputable possession of the territory still in dispute, so as to permit of new treaties being signed to the advantage of France.

Lieut. Simon has just returned to Paris after having brilliantly accomplished the difficult task of which he had assumed the responsibility. Received at Lyons station by delegations from geographical societies, he insisted upon ascribing a part of his success to his colaborers, Messrs. Le Vay and Pi, who seconded him either in the carriage and command of the gunboats of the mission or in his geographical work. It would be impossible to retrace in a few lines all the peripetia of the mission, all the dangers surmounted, and all the difficulties overcome by these valiant officers.

There is one point of their work, nevertheless, that merits attention, and that is the carriage of the gunboats, first by land across the island of Khone, in order to avoid the falls of the same name, and then through the series of rapids of Kemmarat and the obstacles of every nature that rendered the navigation of the upper Mekong so hypothetical before Lieut. Simon demonstrated the navigability of the upper reach by taking La Grandiere thither.

The Massie and La Grandiere were built in France for the colonial service in three months, after plans by Mr. Rueff. These gunboats, divided into five sections, were carried to Cochin China in a steamer. It was thought that the boats doing service upon the lower Mekong, taking advantage of the high water that prevails for three months in this country, might carry the sections as far as to the beginning of the Khone rapids, where they might be disembarked and carried over the impracticable passage; but the sections were too heavy (some of them weighing ten tons) and could not be carried by the boats of the lower Mekong. It was necessary to adopt some other course. Lieut. Simon simply had the two gunboats mounted at Saigon and took them as far as to the foot of the Khone falls, and then, as the water way was no longer navigable at this place, he took the land route. He laid rails upon the island of Khone and carried his two boats, all mounted, through the virgin forest upon wagons and cars.

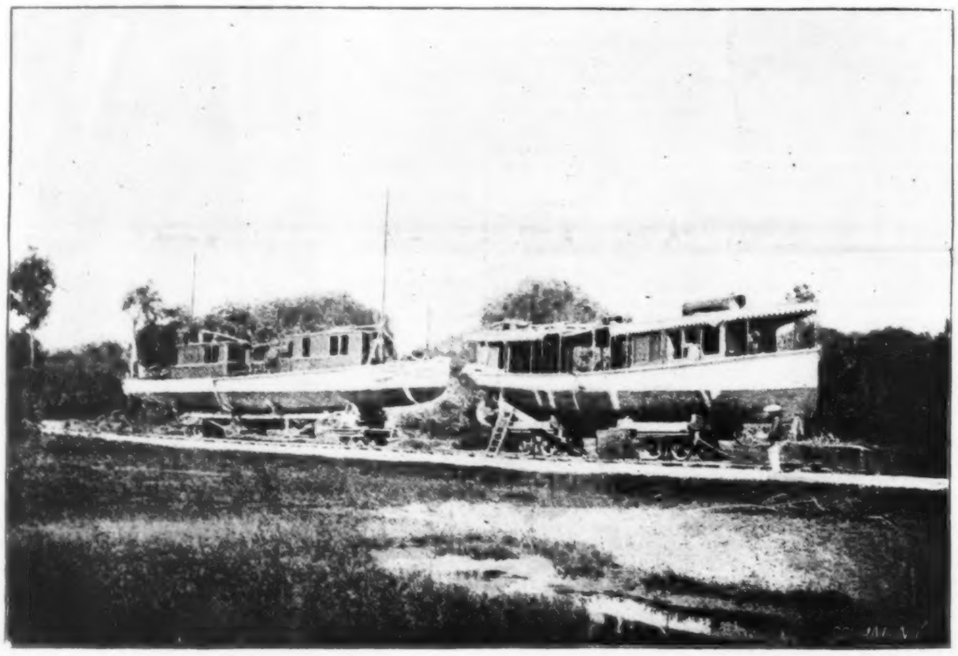
In the first operation, he carried the Massie and the Ham-Luong, a local service boat of Cochin China. The Massie was carried fully mounted, while the Ham-Luong was in two sections. The Ham-Luong assured the service and the protection of the reach from Khone to Bassac and Pakmoun, while Lieut. Simon, crossing the rapids of Kemmarat, took the Massie to a new reach, which was practicable as far as to Vien-Chan.

The indefatigable officer next occupied himself with La Grandiere, which was capable of being carried across the island of Khone upon an improved truck. It was on board of this vessel that Lieut. Simon, after making a very difficult reconnaissance of the river, which was obstructed with obstacles of every nature between Vien Chan and Luang-Prabang, reached the last named place in September, 1895, when the events of Muong-Sin happened.

The English, in contempt of all our rights, were holding military occupation of the left bank of the river and trying to create there a title to the possession of the only valley that, from Burma and Laos, permits of an entrance into China through Yunnan. They likewise claimed possession of the river from Xieng-Sen, and brought from India, by way of Burma, a sectional gunboat to be launched upon this part of the Mekong. They could not be allowed the time to do this, and so Lieut. Simon took La Grandiere to Tang-Ho, on the frontiers of Burma. No one had ever supposed that a gunboat could reach this place. So we may regard as legitimate the pride of our officer, who wrote from this point on October 26, as follows:

"It is not without a certain satisfaction that I am

THE STERN SECTION OF THE HAM-LUONG.



THE MASSIE AND THE HAM-LUONG UPON THE RAILWAY.

THE MASSIE ENTERING THE BASIN OF NORTH KHONE.

able to date this letter from Tang-Ho, this locality being the terminal point of all that one can dare to undertake as regards navigation upon the Mekong. I have been able to reach this place, 1,500 miles from the sea, and at an altitude of 1,560 feet, with a gunboat, after overcoming all the obstacles of the Mekong on this long voyage without the least damage. The crew and material have come out of these thousand dangers intact, and our flag can proudly wave at the stern of the first steam vessel that has accomplished this extraordinary feat with a success that exceeds the most optimistic previsions. At Tang-Ho the Mekong is no longer a river; its bed, which is very narrow from Luang-Prabang, becomes that of a torrent which falls in cascades for a stretch of from five to six miles, thus constituting for navigation a cul-de-sac in which it is unfortunately necessary to stop.

"I do not know what means the future navigators who succeed me will have at their disposal, but I believe it certain that with those at my disposal they will not get beyond Tang-Ho"

This is likewise the opinion of all those who are well acquainted with these remote questions, and who are glad, after following the labors of Lieut. Simon, to register the results obtained—results that are of capital importance for the future of our Indo-Chinese empire.

The presence of three gunboats in the upper reaches of the Mekong is doing more for the security of our frontiers than the erection of numerous forts and the forwarding of numerous battalions. The Siamese, who have for centuries been pillaging and depopulating the rich regions of the left bank of the river, are now obliged to respect our proteges. Aside from the scientific work of the Mekong mission, which is very important, this is a very appreciable political result.

If Lieut. Simon thinks of the thousands of poor Asiatics for whom La Grandiere, the Massie and the Ham-Luong are now protecting genii, the feeling of the good that he has done must appear to him as precious as the glory with which he has just covered himself.—*Le Monde Illustré.*

STATUES OF THE TEMPLE OF BICK-NHO.

THE RUINS OF NHON-TO, CAMBODIA.

NHON-TO is situated at seven miles to the south of Tourane. A single tower 25 feet in height, which seems to be rather the portal of other structures that have disappeared, still remains. There is no trace of sculptures or ornaments. The entire structure, including the fillets and lintels, is of brick. The interior space extends to the flat and closed summit. Vegetation is disintegrating what is left.

Behind the tower an Annamite Buddhist chapel contains three painted sandstone statues of rare workmanship. The middle statue is 3 feet in height and weighs, approximately, 395 pounds. It rests upon an elephant sculptured in the anterior face of the pedestal. The two other statues are 25 inches in height and weigh 155 pounds.

The space comprised between the tower and the pagoda of the village is covered with a forest, as is the region in the immediate vicinity of the ruins.

Farther to the south of Tourane, there are two analogous temples that have, as a common character, the form of the facade that still subsists, and which includes three square brick towers surmounted by a triangular pyramid. The first of these temples, which is situated at about 24 miles to the south of Tourane, is the one that is in the poorest state of preservation. The towers are from 25 feet to 30 feet in height. Remains of sculptures are scattered over the ground in the vicinity, and clearly exhibit the Brahmanic character of the Hindoo statues.

Near this temple there is a stone that bears an inscription which, if deciphered, might give valuable data as to the history of the Khmer or other peoples who constructed these monuments.

The second temple is situated in the village of Bick-Nho, at about nine miles more to the south.

Its three towers, which are pretty well preserved, are at least 50 feet in height. In this temple there are found some Brahmanic statues, as well as three others presenting a different character. These statues, the largest of which is of nearly the height of a man, are of granite and are still partially painted. The accompanying figure, from La Nature, represents two of them. The Annamites have preserved no tradition relative to these monuments.

ON THE ROTATION OF THE EARTH.*

THE recent discovery of periodical variations of terrestrial latitudes demands a revision of the actual theory of the rotation of our planet. This theory, based upon the hypothesis of the absolute rigidity of the earth, admits of variations of this kind, but very different in their laws from those of the observations. The period of revolution of the terrestrial poles given by the theory is one of about ten months. That which the observations give us lasts nearly fourteen months. Still further, the attentive analysis of the observations of the latitudes, executed of late by Mr. Chandler, shows us that the movement of the terrestrial poles is compounded of two others, of which the periods are the one of four hundred and thirty days and the other of twelve months.

Following the order of the ideas established in the science by the celebrated cosmogenic hypothesis of Laplace, we ought to attribute this disagreement of the theory and the observations to the interior fluidity of the earth. But the illustrious physicist, Lord Kelvin, does not admit that the fluid nucleus of the earth may be of considerable enough dimensions. The greatest part of the astronomers of our day adhere to this opinion. They refer the said discordance to the terrestrial globe being elastic.

In considering the hypothesis of a thin rigid crust of the earth as contrary to all given physics, the celebrated English physicist affirms in his memoir "On the Rigidity of the Earth," Phil. Trans., 1863, and in the first edition of the "Treatise on Natural Philosophy" (§§ 847 and 848), that this hypothesis is also incompatible with the observations of the precession and of the nutation. On subsequently withdrawing certain of these astronomical objections, he has replaced them by some others.

To be able to appeal to objections of this kind, the theory of the rotation of the earth considered fluid in its interior ought to have been previously established. Lord Kelvin has not done it. He has limited himself to enunciating in general terms the principal propositions of this theory. To be able to judge of the said objections of the celebrated English physicist, the theory in question must be previously established.

The problem of the rotation of the earth—supposed fluid in its interior—was approached by W. Hopkins in 1839 (Phil. Trans., 1839, 1840, 1842), but the state in which hydrodynamics then was found did not permit the English savant to treat the matter in a satisfactory manner. The more recent attempts to solve this difficult problem have not been more successful.

We shall endeavor in the present article to give a more perfect solution of this important problem. To render this task more easy, we shall assume that the nucleus of the earth is homogeneous, and of the form of a planetary ellipsoid.

The success of our task is assured by the beautiful researches of our clever geometrician, Prof. N. Joukovsky, relative to the movement of a solid body with cavities filled with an incompressible homogeneous fluid. We have only to apply these researches to our special problem. We hope to lessen the difficulties of this application by the supposition that the rotatory motion of the entire terrestrial mass differs very little from the uniform rotation. The proposition of the celebrated Laplace relative to the effect of friction of the fluid parts of the earth upon its rotary motion affords us a solid foundation for the said supposition ("Œuvres Complétes de Laplace," tome v, p. 283).

We shall commence our article with an abridged exposition of the theory of the rotation of a solid body which has a cavity filled with an incompressible homogeneous fluid. In the development of the principal formulæ of this theory we shall employ the most simple method, that of the illustrious Poisson. We shall equally profit by them in our transformations of the hydrodynamical equations.

(The final paragraphs, after thirty large octavo pages of intricate mathematics, are as follows:)

We have taken our problem with some considerable restrictions relative to the form, to the position, to the structure and to the movement of the terrestrial nucleus. This renders almost useless the detailed comparison of our results with the given astronomical ones. We will only say some words relative to one of these results, of which the generality is indubitable.

The hypothesis of a fluid nucleus of the earth being admitted, and the exterior forces neglected, the movement of the terrestrial poles ought to be composed of two periodic movements. The period of the former of these movements is perhaps of twelve or fourteen months, that of the second ought to be pretty nearly a day.

The astronomical observations do not show us this second movement of the poles. Is not this a reason for taking exception to the hypothesis of the fluidity of the earth in its interior? By no means. It is in the first place possible that the smallness of the amplitude of the movement in question may make it unrecognizable. The smallness of the factors μ_3, ν_3, renders this supposition probable. Secondly, it may also be admitted that the want of the appropriate observations causes us to ignore for the present this movement, although its amplitude may be appreciable. One may also suppose that the period of the movement in question, from the usual order of astronomical observations, appears to us to be a period of twelve or of fourteen months. For instance, should the said period be equal to twenty-four sidereal hours exactly, and the observations of the latitude of any astronomical observatory be made every midnight during a good many years, the result of them will be the period of twelve months.

This last supposition appears worthy of attention, because, according to our opinion, the explanation of the period of twelve months by meteorological causes, as is adopted at present by some astronomers, wants probability.

* Abridged translation of a paper by Th. Sloudski, professor at the University of Moscow (Bulletin de la Société Imperiale des Naturalistes de Moscow. Année 1895, No. 2), in Nature.

THE TREATMENT OF HÆMOPTYSIS.*

CONSUMPTIVES are in many respects a very peculiar class of patients. The hopefulness which is a part of their disposition, and which almost always accompanies their disease, leads them to regard many indications of failing health in their own bodies with indifference, no matter how self-evident this may be to their relatives and friends. They feel out of sorts, experience a constant tiredness, and are perhaps a little more irritable than formerly. They also complain of an impaired or capricious appetite, lose in weight, become a little feverish in the afternoon or evening, have a slight cough and expectoration, and pass restless and dreamy nights; yet none of these symptoms seem to draw their attention to themselves until, greatly to their surprise, they are suddenly seized with spitting of blood. No matter how small the amount of blood may be that is brought up, there is nothing that will alarm or demoralize a patient more than this. This seems to bring him to his senses, for he now almost invariably seeks medical relief.

This is one kind of hæmoptysis which comes under observation. Another is that which occurs in the following manner: A patient may or may not have slight blood spitting at the beginning of his disease, and may go through its various stages to the point of excavation without any recurrence of this trouble. But all at once, and without any apparent reason, he is seized with a violent hemorrhage—the blood gushing out of his nose and mouth—and he seems to be in imminent danger of bleeding to death.

These two kinds of hemorrhages make up the principal types of hæmoptysis which are met in practice. The first emanates from a rupture of the bronchial or pulmonary capillaries, or from an extravasation or oozing of blood through and from the walls of these blood vessels; and the second comes from a break in the walls of an exposed and unsupported aneurysmal artery or vein on the surface of a cavity. The difference between these two types mainly consists in the amount of blood which is lost to the body, and in the ease or difficulty with which the blood flow can be checked in each. Practically, the first deals with those cases which have no cavity, and, so to speak, are in the first stage of the disease; while the second comprises those cases which are burdened with a cavity and are therefore in the third stage of the disease.

The first aim in the treatment of hæmoptysis is to make the patient comfortable, both physically and mentally. Place him at rest on his back in bed, and administer a dose of morphine and atropine hypodermically. If the bleeding does not come from a cavity, or does not appear too copiously, assure him that in reality the hemorrhage has no serious significance; that the bleeding is not only harmless, but may be an actual benefit, since it unloads and relieves the congested condition of the affected area. This will tend to allay his fear and nervousness more than anything else, and if you succeed in doing the latter, you will have gained an important point in the management of your case. Insist on keeping the patient quiet in bed, and above all avoid a physical exploration of the chest at this time, since the shock coming from percussion, and the strain on the lungs due to forced breathing, will serve to aggravate his condition.

At this stage of the treatment do not fly to the giving of routine remedies like ergot, gallic acid, hamamelis, or geranium, but make inquiry as to the possible cause of the hemorrhage, provided, of course, it does not come from a cavity. Find out first of all whether syphilis, rheumatism, or malaria plays any part in the personal history of the patient. This is very essential, since it often gives you a correct clew to the treatment of the affection.

Syphilis.—If there is any evidence of syphilitic infection, place him at once on a thirty-second of a grain of the corrosive chloride of mercury, or a quarter of a grain of the green iodide of mercury, or five grains of potassium iodide, four times a day. In doing this you neutralize and antagonize the dyscrasia which may lie at the foundation of the bleeding, and this goes a great

* A lecture delivered in the Philadelphia Polyclinic by Thomas J. Mays, A.M., M.D., Professor of Diseases of the Chest in the Philadelphia Polyclinic, and Visiting Physician to the Rush Hospital for Consumption. From the New York Medical Journal.

way toward abating the latter difficulty. These agents may be given in connection with any other appropriate remedy at the same time.

Rheumatism.—Dr. Haig, in his work on uric acid, speaks of the important relationship which exists between uric acid and many cases of hæmoptysis, and advocates the administration of the salicylates under such circumstances. At first sight this connection may seem rather vague, but the good effects which follow such a line of treatment make it altogether obvious. There is no doubt in my mind that uric acid sustains some causative relation to pulmonary blood spitting, for I have seen many striking examples in which the sodium salicylate exerted greater hæmostatic properties than anything else which was administered. The following is a typical example of this influence:

D., aged eighteen years, single, six feet two inches tall, with a marked heredity of pulmonary consumption and asthma on both sides, although his father and mother are alive and well, began to expectorate blood a month before he came under my observation. Just previous to my first visit he had profuse hæmoptysis, and when I saw him he was in bed and still spitting blood. He was plethoric and apparently in good health otherwise, but complained of a fullness and constriction in his chest, and was unable to take a full breath. He also stated that his hands and forearms were numb and felt as if they were asleep. I gave him morphine, ergot, hamamelis, and geranium, as well as quinine. On the two following days he had several large hemorrhages, and the oppression in the chest and numbness in hands and forearms remained. On the evening of the third day he began to develop a slight but distinct pain in the finger joints, wrists, elbow, and shoulder joints, and the numbness in his forearms was probably a little more marked. I placed him at once on the use of the following combination, and discontinued the ergot and hamamelis mixture:

℞. Sodii salicylatis....................		ʒ ijss.;
Potassii acetatis............		ʒ j;
Tinct. digitalis...........	f	ʒ iij;
Aquæ menth. pip.........	f	℥ j;
Tinct. cinch. comp ....q. s.	f	℥ iv.

M. Sig.: A teaspoonful and a half every four hours in water.

The bleeding ceased, and he improved from this time. The oppression in his chest and the numbness in his hands and arms disappeared promptly.

This was my first case of hæmoptysis in which I was brought fully to realize that rheumatism might become one of its important complications and serve to point out the proper line of giving relief, and this fortunate realization I ascribe wholly to my familiarity with the work of Dr. Haig. I have seen the same condition since in other cases, and met its therapeutic indications by administering the salicylate of sodium in proper doses. I feel quite certain, however, that I saw the same phenomenon before, but failed to recognize its importance.

In treating hæmoptysis it is necessary, therefore, to look for some active manifestation of the rheumatic diathesis either in the patient or among his immediate relatives. This may be wanting in the patient until the hæmoptysis is firmly established, as was the case in the instance above related; but if there is a strong hereditary tendency to rheumatism, it is probably always advisable to administer some of the salicylates or some other antirheumatic agent from the very beginning of the bleeding. I recommend the salicylates in this affection because my experience has been limited to the use of these agents, but Dr. Haig also advises the giving of mercury iodide for the same purpose.

Malaria.—Sometimes hæmoptysis is at least aggravated by the malarial poison, and when there is reason to suspect any malarial influence at work, it is always good practice to give quinine in full doses.

Ice-cold Applications.—In some cases without a cavity the hæmoptysis is so copious that no medicinal agent given internally is able to subdue it, and under these circumstances resort must be had to the local application of ice to the chest. This is effected by filling one, two, or three rubber bags with ice (the number of these is governed by the indications), which are wrapped in towels and brought in immediate contact with the skin. By this means you will be able to check the bleeding, and in the meantime you will be given a chance to attack and, if possible, to remove the underlying diathesis, if this is present, and thus be able to check the hemorrhage permanently. There is a certain amount of unnecessary fear of, and prejudice against, the use of the ice bag in this or in any other disease which prevent its application and foster the idea that it should be held as a last resort. This is a serious mistake. Be guided by the amount of blood and the degree of persistence with which it comes from the lungs; if this is profuse, apply the ice from the very beginning.

Other drugs than those mentioned above which are valuable in the treatment of this affection are ergot, opium, lead acetate, hamamelis, gallic acid, and geranium.

Hæmoptysis from a Cavity.—This is always a grave complication. In most instances of this kind there exists a rupture of an exposed blood vessel on the surface of the cavity, and the difficulty which is encountered here is the uncertainty as to how large a blood vessel is involved, or as to the extent of the rupture. If the lesion is vast it is evident that no remedy, whether applied internally or externally, will reach the trouble, and in such cases sudden death may be looked for. Do not, however, give up hope because the blood proceeds from a cavity. Apply the ice, give a hypodermic injection of morphine, and keep your patient very quiet. Very often, after the bleeding ceases, and there is not too much secondary disturbance of the constitution, these cases will make rapid improvement. On the whole, cavity cases are not so desperate and hopeless as they seem. I believe that a cavity case has better prospects than another case in which softening is going on, or one in which there are spots of infiltration dotted over the whole lung surface, and this for the following reason: After a cavity is once formed, and becomes dry or nearly so, this is clear evidence that there is sufficient vital resistance in the remaining lung tissue to check the encroachment of the disease, which is not true while softening is going on or while infiltration is active, especially not if the latter occurs in isolated areas. Softening being once started, there is an uncertainty as to where it will stop, but a cavity once formed is proof that the degenerative process is circumvented and held in abeyance by the vital forces.

Pulmonary Rest.—This brings up the important question whether patients who have a tendency to hemorrhage, either from a cavity or from any other source in the lungs, should practice pulmonary gymnastics or not. My own conviction is that they should not, although I know that this opinion is not universally indorsed. My experiences teaches me, however, that any undue functional activity of the lungs in this condition is at all times hazardous. I have seen blood spitting supervene the inhaling of compressed air or coming on after such patients take a number of deep breaths successively. I remember one patient in whom blood spitting occurred after undergoing auscultatory examination of the chest on two separate occasions. Avoidance of deep breathing for a while stopped this effectually.

High-altitude Treatment.—The ever-recurring question is, Should patients with a disposition to blood spitting be sent to high altitudes? From a theoretical standpoint I think many objections may be raised against such a change, but practically I believe that high altitudes have no detrimental effect on this condition; on the contrary, it seems that nearly all such cases derive benefit from this kind of treatment.

ON THE DIFFRACTION OF THE ROENTGEN RAYS.

By L. CALMETTE and G. T. HUILLIER.

WE have the honor of submitting to the Academy some photographic proofs obtained with the Roentgen rays by means of the following arrangement:

Very near the Crookes tube there is a screen, E, of brass perforated by a slit, the width of which has rarely reached a half mm. A second metal screen, E′, is formed of a plate provided with two slits or pierced with a window in which is fixed a metal rod of 1 mm. in diameter, this screen is placed at the distance, a, behind the former. Lastly, a photographic plate, enfolded in two leaves of black paper, is placed at the distance, b, behind the second screen, E′.

The following table indicates, for each proof, what is the screen E′ used, and the value of a and b + a:

No.	E′.	a. Cm.	b+a. Cm.
1.	Rod of 1 mm. in diameter........	5	19·5
3.	" "	5·5	20
5.	" "	8·9	30
7.	Two narrow slits, separated by a cylindrical rod of 1 mm. in diameter	?	?

On the proofs 1, 3, 5 the shadow thrown by the metallic rod is bordered on each side by a light band which shows a maximum of intensity. Within this shade we observe a zone less dark, which seems to indicate that the Roentgen rays penetrate into the geometrical shadow. Lastly, in proofs 3 and 5 we see, in like manner, a maximum of intensity along the margins of the window in which the rod is placed.

In the proof No. 7 we perceive, in the middle of the two white bands, a fine dark ray, while in the shadow of the rod which separates the two slits there is seen a light ray.

If we compare these results with those obtained with light in the same conditions, the slit being relatively wide and the intensity weak, it seems difficult not to ascribe them to the diffraction of the Roentgen rays.

The proofs obtained in these experiments—which we propose to continue—are not yet so distinct that we can measure the wave length with any precision. But we are still led to believe that this wave length is greater than that of the luminous rays.—Comptes Rendus.

APPLICATION OF PHOTOGRAPHY BY ROENTGEN RAYS TO ANALYTICAL RESEARCHES ON VEGETABLE MATTER.

By FERNAND RANVEZ.

PHOTOGRAPHY by means of the X rays can render precious services in analytical research, and especially in the analysis of vegetable articles of food, where it will detect certain of the most frequent falsifications—those effected by the addition of mineral substances.

This method offers manifold advantages; it requires only small quantities of the substances; it leaves the specimens completely intact; it allows us to effect in a very short time a great number of examinations (about a quarter of an hour sufficing for a series of specimens). Lastly, the proof obtained is a piece of convictive evidence quite demonstrative, easily understood even by persons strange to any analytical operation.

The experiments which I have made refer to three samples of falsified saffron, taken in trade. These products consisted of mixtures in different proportions of pure saffron and saffron coated with barium sulphate. The filaments of the latter were found surrounded with a shell of mineral matter. The adulteration was very skillfully masked, and could not be suspected on a mere inspection of the merchandise.

I arranged on one and the same sensitive plate, inclosed in black paper, quantities of the three adulterated samples almost equal. No. II contains 62·13 per cent. of mineral matters, No. III, 28·69 per cent., No. IV, 22·21 per cent., and along with them a specimen of pure saffron. The whole was submitted for three minutes to the influence of the rays emanating from a Crookes tube.

The pure allowed itself to be traversed by the X rays and produced on the proof merely shadows scarcely visible, not acting, so to say, upon the paper of the positive proofs. The three falsified samples acted strongly upon the sensitive plate, marking very distinctly the filaments coated with barium sulphate, while the stigmati of the pure product, which were mixed with it, appeared only as scarcely perceptible shadows analogous to those of the former product.

The photographic proofs which accompany this note show the distinctness of the results obtained, and enable us to foresee the services which this method will render in its future applications.—Comptes Rendus.

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TABLE OF CONTENTS.